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CASTING BRASS UNDER MODERN CONDITIONS

The Efficient Methods of the Yale & Towne Mfg. Co. and Details of Its Specially-Equipped Shop

By H Cole Estep

WHEN the Yale & Towne Mfg. Co. concluded to build a new brass foundry to take the place of a structure that has been in use for a good many years, a decision was made not only to try and erect a plant that would embody all the latest ideas in equipment and arrangement tending toward rapid and economical production, but also to give due consideration to the safety, comfort and particularly the health of the employes. The officials of the company felt that this decision was justified both from a humanitarian

FIG. 1—THE MACHINE MOLDING DEPARTMENT IS CAREFULLY ARRANGED AND FRESH AIR IS DELIVERED TO EACH MOLDER THROUGH MUSHROOM HEAD VENTILATORS

standpoint and from a consideration of sound business principles. In state legislatures and elsewhere serious criticisms have been made of conditions existing in many brass foundries due principally to the exposure of the workmen to poisonous zinc fumes arising from molten metal and in many cases these criticisms have been justified. The danger to health resulting from exposure to an atmosphere laden with zinc dust was clearly pointed out in a paper on "Safety and Sanitation in the Brass Foundry", read before the American Foundrymen's Association in Chicago in September, 1914, by Frederick Morel and published in *The Foundry* in October 1914. Practically all of the pathological difficulties arising in brass foundry work, however, may be corrected by proper ventilation and this subject was given unusual thought in the design of the Yale & Towne foundry, with results that are believed to be noteworthy.

The Yale & Towne Mfg. Co. is one of the most widely known concerns in the United States, its principal product, Yale locks and builders' hardware, being extensively used all over the world. The manufacture of locks and hardware specialties on an extensive scale necessitates the production of large quantities of brass and bronze castings. These castings must combine strength with the property of taking high finish. A large number of different mixtures are employed and many of the castings are complicated and of an ornamental character. Comparatively little heavy work is handled; most of the castings are extremely light and the average weight does not exceed eight or ten ounces. To take care of present and future needs, the new Yale & Towne brass foundry is designed for an ultimate capacity of 20 tons per day.

How the Plant is Arranged

The foundry at Stamford, Conn., is divided into three parts, including a one-story molding room, 133 feet wide and 297 feet long, with a one-story melting room, 60 feet wide and 297 feet long on one side, and a three-story service building, 52 feet wide by 297 feet long, on the other side. The molding room has a saw-tooth roof designed to furnish maximum natural illumination. The head room is low, the bottom chords of the roof trusses being 12 feet from the floor, the trusses themselves being 4 feet 4½ inches in depth. The roof over the molding room is of asphalt and slag composition. The melting room has a high arched monitor roof carried on steel trusses as indicated in Fig. 3. The head room is about double that in the molding room for purposes of ventilation. The roof trusses in the melting room are spaced on 14-foot centers. The service building is a modern fireproof structure; one end is used for pattern storage and the remainder contains the cleaning, trimming and sorting, core-making, pattern-making and welfare departments. Reinforced concrete slabs 6½ inches thick supported on 14-foot centers form the floors for the first, second and third stories. The slabs are reinforced with Clinton wire cloth having a 2 x 12-inch mesh. On the two lower floors a covering of 2-inch planks is laid over the concrete slabs, a ⅞-inch maple floor being nailed to the planks, which are held in place by 1¾ x 3¾-inch screeds laid on 16-inch centers in a tar filling. The core-making department occupies the third floor of the service building and a vitrified brick pavement is provided instead of a wooden floor.

The relative arrangement of the various departments is shown in the plan, Fig. 5. The melting room is provided with two 36-pot coal-fired melting furnaces and 18 stationary and tilting oil-burning furnaces, together with mold-drying stoves and facilities for mixing metals and reclaiming good metal from dross. As indicated in Fig. 5, over half of the molding room is utilized for bench molding, the remainder being devoted to machine molding and sand handling. The cleaning department occupies a portion of the first floor of the service building adjacent to the molding room. The remainder of this floor is given over to toilet and locker rooms and to pattern storage. The latter takes up the entire end of the service section of the building, and is separated from it by a fire wall. It is arranged with metal floors at six floor levels,

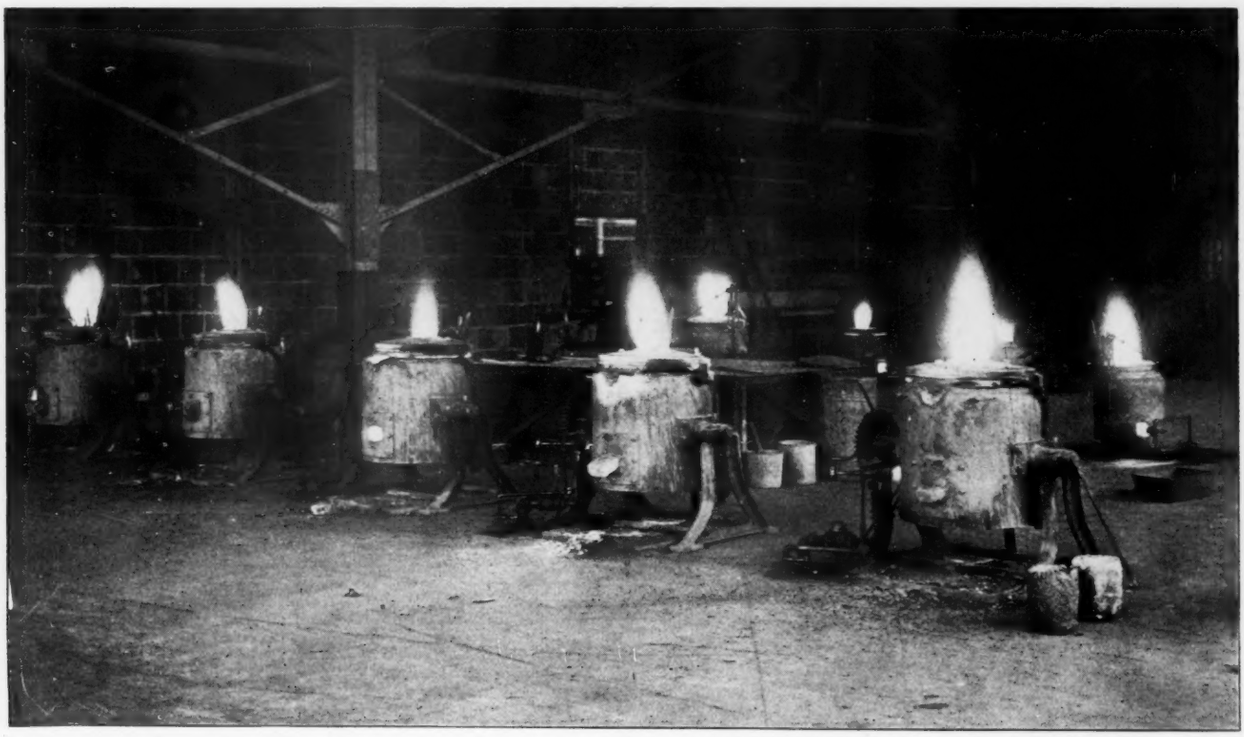

FIG. 2—A LARGE NUMBER OF OIL FIRED MELTING FURNACES ARE INSTALLED

FIG. 3—SPECIALLY DESIGNED 36-POT COAL FIRED BRASS MELTING FURNACE

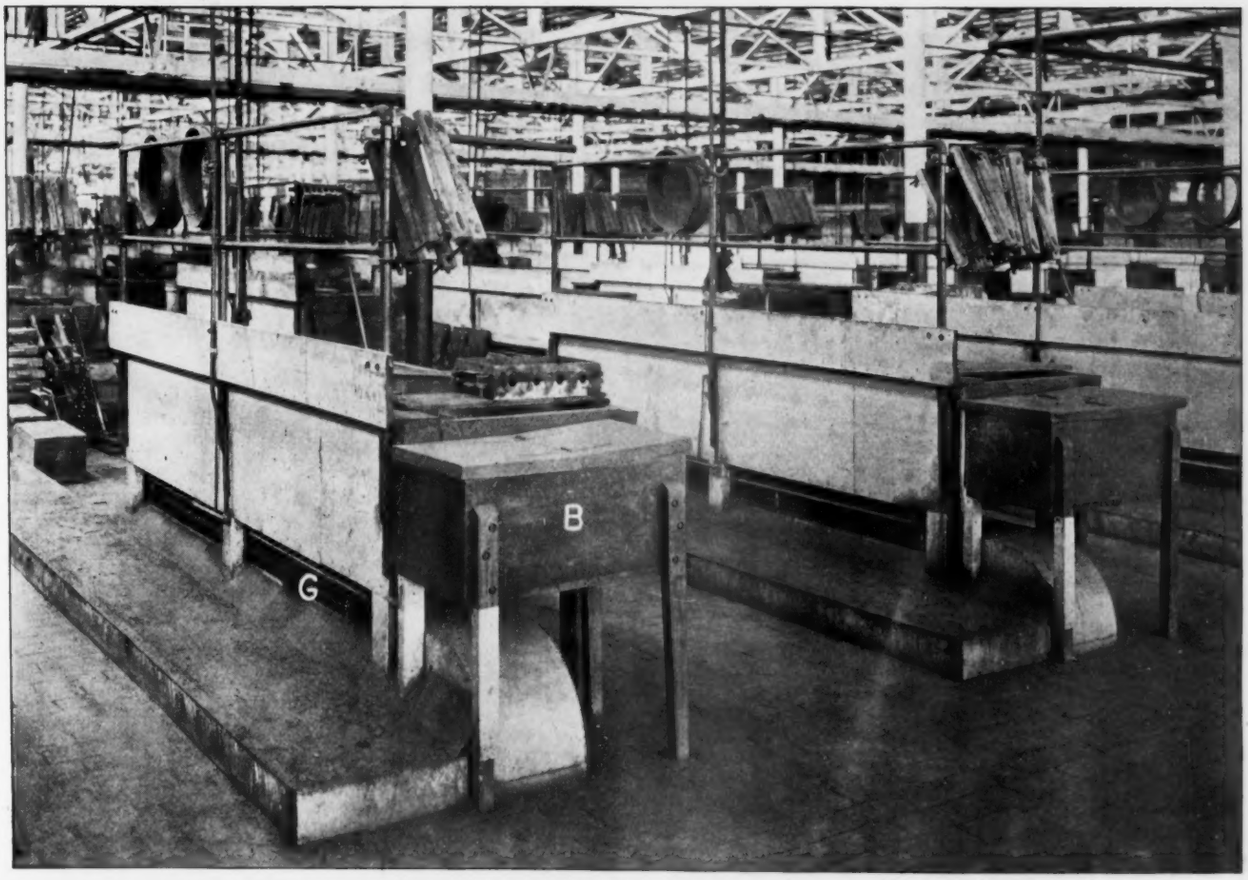

FIG. 4—CLOSE VIEW OF MOLDER'S BENCH SHOWING FRESH AIR GRATING AND BOX FOR FACING SAND

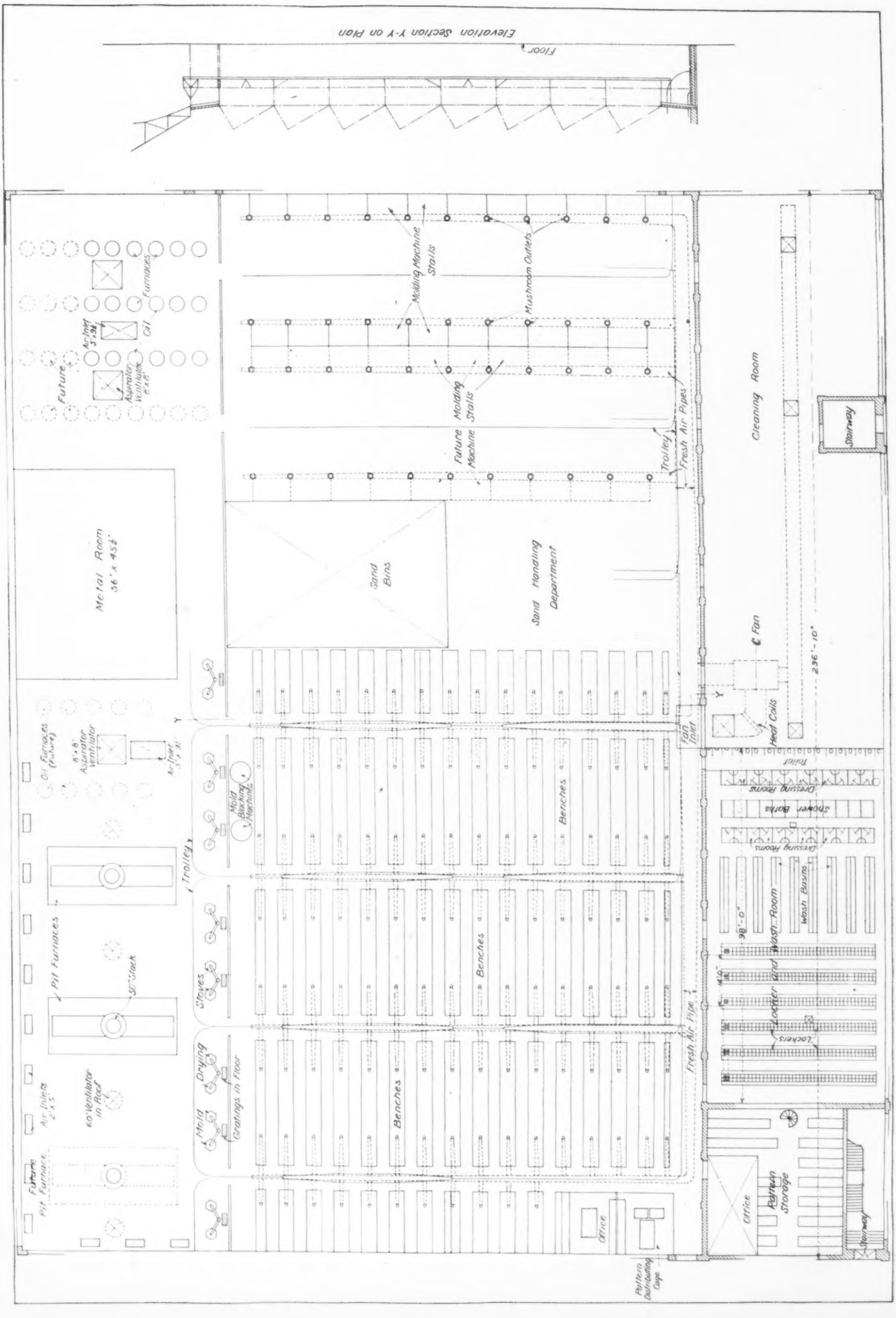

FIG. 5—PLAN OF YALE & TOWNE BRASS FOUNDRY

with an electric elevator for the distribution of patterns from any floor level to the ground floor, where they are checked out with casting orders. The pattern-making and modeling departments are located on the second floor of the service building and the core department is on the third floor. A greenhouse has been built on the roof.

Results of Good Ventilation

As a result of careful study the ventilation is exceptionally good throughout the entire plant. The melting room is clear of smoke and fumes at all times; this is indicated by Figs. 2 and 3. The photographs from which these illustrations were made were taken when the plant was in operation without interrupting any of the work. Although metal is being poured in the molding room continuously, the fumes and gases are carried away as fast as they are generated and a clean, wholesome atmosphere is maintained at all times. Figs. 1 and 7 were made from photographs taken in the molding room while the plant was in operation and when pouring was going on. As a result of the careful attention given to ventilation, the employes are healthier and more contented and the volume of work per man per day has been increased, without any apparent increase in effort and with less fatigue. The ventilating system was designed and installed under the supervision of Stewart A. Jellett, Philadelphia. Mr. Jellett also designed the heating, plumbing, lighting and sprinkler systems.

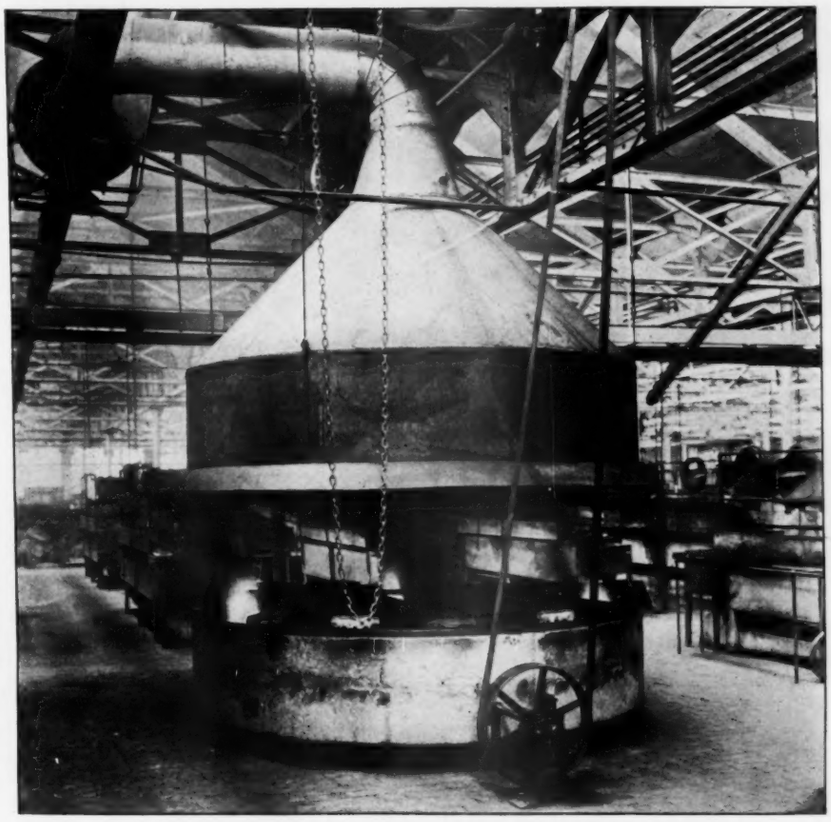

FIG. 6—MACHINE FOR SMOKING MOLDS WITH ROSIN FUMES

A positive ventilating system has been provided and two fans have been installed; one furnishes the fresh air and the other exhausts vitiated air from the service building. The main air supply is drawn in through an opening over the roof of the molding room and is delivered to the ventilating ducts by a 7/8-housed No. 20 Sturtevant multi-vane fan. This fan delivers 94,000 cubic feet of air per minute when running at 115 revolutions per minute, with a consumption of 29 horsepower. The building is designed for a future extension of 80 feet and with the air supply system extended in a corresponding degree, this fan ultimately will deliver 117,000 cubic feet per minute. The air is drawn through three groups of four-row Sturtevant pipe coil heaters and warmed to 70 degrees Fahr. From the fan it is discharged into a concrete duct running east and west below the molding room floor. The west branch of this duct at the connection with the fan has a cross section of 62 x 75 inches, from which it tapers to 24 x 54 inches; the east duct has an initial cross section of 69 x 75 inches tapering to 45 x 62 inches. It is the latter branch which will be extended when the foundry is enlarged. The air is delivered from the concrete duct into sheet iron laterals running north and south with branches leading to each molder's bench. The latter pass through the floor and connect with a long goose neck under each bench, the air being discharged through a grating as indicated at *G*, Fig. 4. The general arrangement of the ventilating ducts is suggested in Fig. 5. The air is discharged at low velocity directly onto the flasks. This arrangement, of course, applies only to the bench molding department located in the west end of the room.

On the east side of the room in the molding machine department, the air is discharged through 12 x 12-inch branches extending vertically through the floor to a height of about 3 feet. These branches are fitted with a cast iron mushroom-shaped cap provided with a deflector to distribute the air and direct it toward the floor. These mushroom air outlets are shown clearly in Fig. 1.

The air supply system is based on six changes per hour throughout the plant. The new molding room is ventilated by means of 152 20-inch round Burt ventilators set in the peaks of the saw-tooth roof. The purpose of the air supply system, it will be noticed is to deliver fresh air close to the floor and drive off the vitiated air at the ceiling. This rising current of air carries away the fluffy zinc oxide which is always present during pouring operations. The fumes and smoke also are carried away and the atmosphere is cleared rapidly.

A branch from the main air supply fan is taken from the scroll in the foundation and turned back and connected to a sheet iron duct extending underneath the service building. From this duct vertical flues are led up through the building with registers discharging near the floor lines in each story. A branch from the main duct also is extended underneath the locker room and a large quantity of air is discharged directly under the lockers in order to dry the workmen's clothing rapidly.

Ventilating the Service Building

The service building is ventilated by vertical flues which extend through the building increasing in size as they approach the top floor. Registers are located on these flues near the ceiling. One of these is shown at *R*, Fig. 9. The flues are gathered into a main duct on the third floor which extends

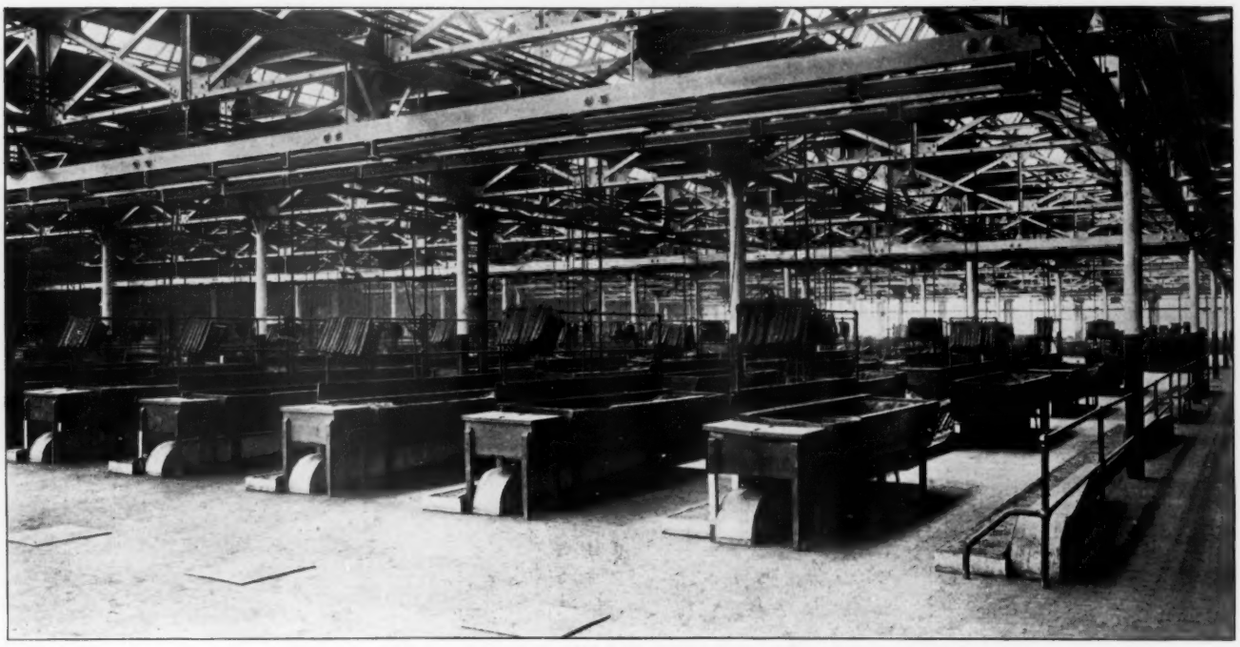

FIG. 7—A SECTION OF THE BENCH MOLDING DEPARTMENT

through the roof and connects with the suction of the exhaust fan. The latter is located in a pent house on the roof and discharges out of doors.

The locker and toilet rooms on the second and third floors are provided with separate flues and ducts, connecting to the exhaust fan mentioned in the preceding paragraph. The fan handles 22,700 cubic feet of air per minute, with a consumption of approximately 4 horsepower. The large inlet fan works against a static resistance of approximately 0.6 of an inch of water; the exhaust fan works against a resistance of approximately 0.4-inch. The air ducts are made of galvanized sheets as described previously; those under the floor are 20 gage and the remainder are fabricated from 22 and 24-gage stock, according to size. The vertical stands in the molding machine section are constructed of No. 12 gage material. The air supply grills under the molders' benches are provided with No. 14 gage diamond mesh screen.

The air supply to the locker rooms on the second and third floors enters through cast iron wall boxes connecting to cased-in passages underneath the lockers which are perforated at the bottom. Exhausting the vitiated air from the room thus draws fresh air through the lockers themselves.

All of the warm air ducts below the building are insulated with 1-inch cork board fastened securely to the metal ducts with copper wire. The joints are filled with cement and the entire covering is made tight. This was necessary as the building is set up from the ground due to the nature of the soil, leaving an exposed space below the floor.

The melting room is ventilated by means of large ventilators or aspirators, 8 feet square, in the peak of the roof. They are placed immediately over the oil-burning furnaces shown in Fig. 2. The hot gases from the furnaces carry with them large quantities of air discharged through the aspirators. In addition, four 60-inch

FIG. 8—OIL-FIRED CAST IRON DRYING STOVES

FIG. 9—CLEANING AND TRIMMING DEPARTMENT

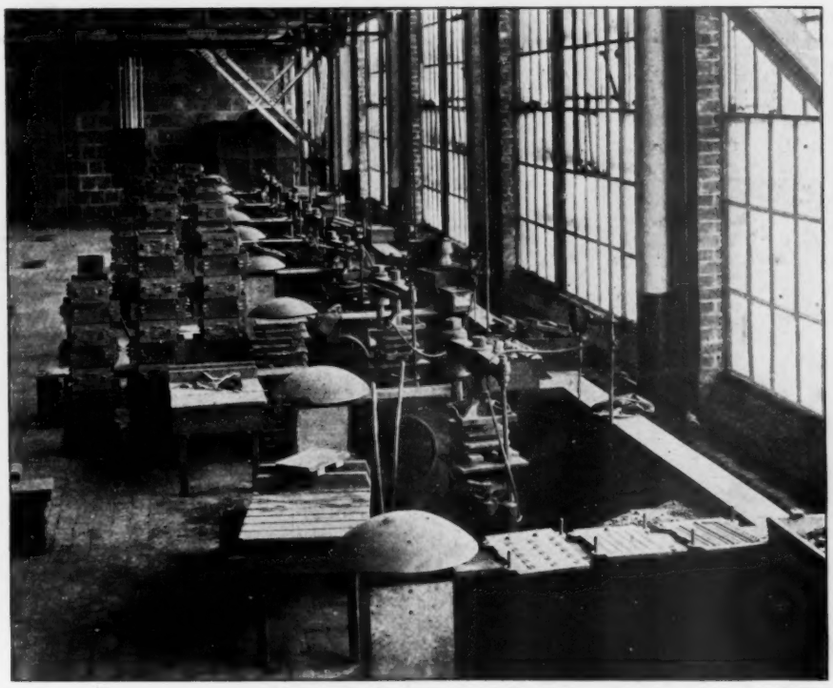

FIG. 10—SWING HEAD AIR SQUEEZER MOLDING MACHINES—NOTE MUSHROOM HEAD FRESH AIR OUTLETS

ventilators are installed over the pit furnaces at the west end of the room. The holes in the roof for the smoke pipes from the mold drying stoves are 28 inches in diameter, the pipes themselves being but 10 inches; the annular aperture thus formed is used for ventilation and the smoke pipe is provided with a hood to keep the rain from beating in around it.

Air is admitted to the melting room through slatted openings 2 feet wide and 5 feet long, and 5 feet wide and 9½ feet long, the smaller openings being at the western end. A heavy table, 3 feet high, is constructed over each of the openings and grills are fitted on the four sides. As the space underneath the melting room is entirely open, all of the air carried up through the ventilators by the heat from the furnaces must be replaced by cool air which rushes in from below, thus rapidly carrying off the fumes and smoke and furnishing an ample supply of fresh air to keep the room comfortable at all times even in the summer.

Heating System

The heating system is designed to warm the service building and pattern storage to 68 degrees Fahr.; the molding room is heated to 60 degrees. The melting room is not provided with any radiating surfaces as the furnaces in this department supply sufficient heat to warm the building even in the coldest winter weather. A two-pipe vacuum steam heating system is employed. The main supply enters the building underground in the locker room, rising at the point of entrance and extending across the ceiling of the first floor to the molding room. The radiating coils are located overhead in the molding room under the sky lights in the saw-tooth roof and wall radiators also are provided below the windows on each side of the building. The service building is heated throughout with wall radiation located below the windows along the outer walls. These are fed with an overhead downfeed system. Heating coils are supplied underneath the lockers on the second and third floors. The return risers are connected into a system of mains located underneath the ground floor. The latter are extended to the outer wall of the pattern storage building where they connect to a 4-inch vacuum main leading to the vacuum pumps. The return end of each radiator unit is provided with a Webster vacuum valve. The lines supplying the coils in the molding room are separately controlled and the air supply heaters, wall radiators and hot water generator also are separately controlled. The hot water generator has a capacity of 500 gallons and is arranged for low pressure steam supply so that exhaust steam may be used on the entire equipment.

Melting Equipment

At the present time the melting department is equipped with two 36-pot coal-fired pit furnaces and 18 individual oil-burning furnaces; the coal furnaces are located in the western end of the building and the oil furnaces at the opposite end. In between is a metal room, 45½ x 56 feet in size. Space also is provided for the future installation of an additional 36-pot coal furnace and 28 tilting oil-burning furnaces.

Fig. 3 shows the general arrangement of the pit furnaces. They are worked with No. 25 crucibles holding about 80 pounds of metal each. Each furnace takes off about five heats per

FIG. 11—ADEQUATE FACILITIES ARE PROVIDED TO PREPARE AND MIX FACING SAND

day. The coal is stored in bins between the two furnaces as indicated in Fig. 3. The furnaces are constructed with a separate flue for each crucible compartment; the flues lead to a steel stack 50 inches in diameter. The overall dimensions of the furnaces are 8 x 38 feet.

The oil-burning furnaces, which are of the Steele-Harvey type, were furnished by the Monarch Engineering & Mfg. Co., Baltimore, Md. Six stationary and 12 tilting furnaces are installed; the tilting furnaces are shown in action in Fig. 2. Some of the stationary furnaces may be seen in the background of the same illustration. One of the tilting furnaces is designed for a No. 275 crucible; it is used for melting scrap. Four of the remaining 11 tilting furnaces are designed for No. 125 crucibles and seven for No. 60 crucibles. One of the small pit furnaces is used as a crucible heater. Two No. 4 Garden City blowers are installed for furnishing the blast to the oil-fired furnaces.

As mentioned previously, a great many different mixtures are employed in the production of locks and hardware for various purposes and the facilities for storing, weighing and mixing metals in the metal room are extensive. In addition to other equipment, this department is provided with two 110-volt magnetic separators designed to operate at 420 revolutions per minute. They were furnished by the Dings Electro-Magnetic Separator Co., Milwaukee. Two water mills also are provided for reclaiming good metal from dross.

The molten metal is transferred from the melting room to the molding floor by means of an overhead trolley system furnished by the Coburn Trolley Track Mfg. Co., Holyoke, Mass. The trolley rail in the west end of the melting room is shown at *T*, Fig. 3, and the general arrangement of the trolley track system is shown in Fig. 5.

FIG. 12—A CORNER IN THE PATTERN STORAGE DEPARTMENT

Specially Designed Molders' Tubs

The molding room, as mentioned previously, is 133 feet wide and 297 feet long. Over half of the floor space is devoted to bench molding; a third of the remaining space is utilized for sand handling and the balance for machine molding.

A section of the bench molding department is shown in Fig. 7; space is provided for 125 one-man molding tubs. The tubs are arranged in rows with aisles leading to the melting room, as shown in Fig. 5. A close view of one of the tubs is shown in Fig. 4. Owing to the large number of ornamental castings which are made, a considerable quantity of facing sand of various kinds is used. It is kept in a covered box, *B*, Fig. 4, situated at the end of the tub. The facing sand, properly prepared and riddled, is delivered to the molder twice a day. The molder takes care of his own tub sand. The backs of the benches, as shown in Fig. 4, are sheathed with galvanized steel. The finished molds are placed on the sand pouring bed in front of the bench. Each molder, of course, places his molds on the pouring bed immediately behind him, so as to avoid walking around the bench. The molds are walked-off instead of being rammed with a hand rammer and the ropes shown in Fig. 4 are provided for the convenience of the molder in performing this operation. An annunciator system is being installed so that it will not be necessary for the molder to walk over to the office to find out what to do next when he finishes a job. When this system is in operation, the molder simply will push a button a few minutes before he is through with the job at which he is working and shortly thereafter the clerk in the office will advise him what to do next.

Many of the molds for ornamental castings are skin dried and for this purpose 16 oil-fired drying stoves, Fig.

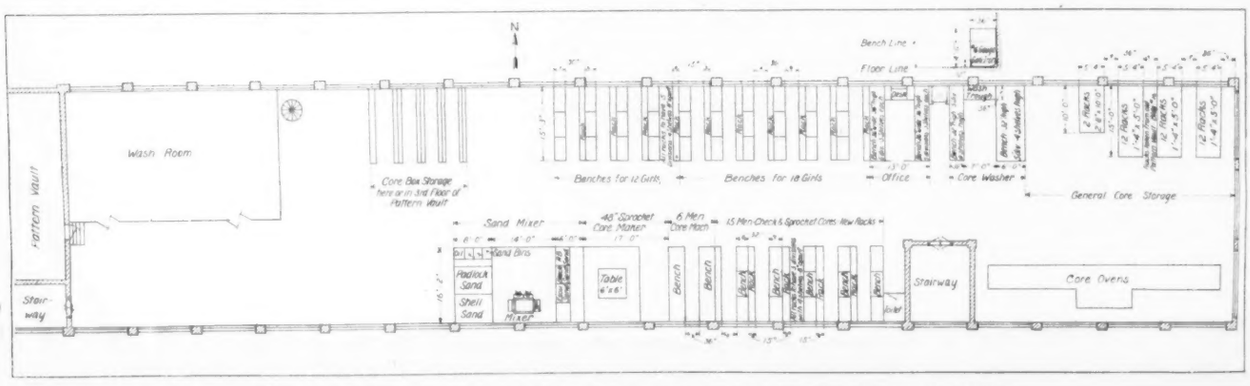

FIG. 13—PLAN OF CORE ROOM ON THIRD FLOOR OF SERVICE BUILDING

8, have been installed along the south wall of the melting room as shown in Fig. 5. The stoves are hexagonal so that six molds may be dried at one time.

The molds are supported on lugs which are cast to the bottom of the side plates of the stove. The flame enters the stove tangentially and whirls around a firebrick core which drives the heat out toward the circumference. Holes are cored in the side of the stove so as to expose the molds directly to the heat. The molds are dried on the stoves from 12 to 15 minutes each.

Some of the dried molds are further finished by blacking with rosin smoke and some of the green sand molds also are treated in the same way. For this purpose two blacking machines have been installed, one of which is shown in Fig. 6. The molds are supported around the periphery of the machine in a circle, and the rosin pots are carried on a frame work which rotates underneath. A hood is provided over the machine to carry away the smoke; it is connected to an electrically-driven exhaust fan to insure a positive ventilation.

Extensive Machine Molding Facilities

Two views of the molding machine section are shown in Figs. 1 and 10. The machines, it will be noted, are arranged in separate stalls, the molds being laid on the floor under the trolley track which leads to the melting room. Space is provided for the operation of 40 machines. At the present time seven swing-head squeezer machines, Fig. 10, and nine Berkshire hand squeezers, Fig. 1, have been installed, together with one Tabor squeezer. The swing-head squeezers are operated by compressed air. The machine production ranges up to 150 molds per day, depending on the class of work handled. Each molding machine floor is individually ventilated through a mushroom head duct, as described previously.

The sand-handling department is shown in Fig. 11. It is situated in the middle of the molding room as indicated in Fig. 5. The molding sand is stored in large bins shown at the rear in the former illustration, and the various fine sands which are used for making up facings of different kinds are stored in the small bins shown in the foreground. These bins are 6 feet long, 4 feet wide and 3½ feet in height. They are provided with pipe coils carrying steam to keep the sand dry. A duplex shaker furnished by the Brown Specialty Machinery Co., Chicago, and a gyratory riddle, furnished by the Great Western Mfg. Co., Leavenworth, Kan., are provided, together with a set of crushing rolls. The sand is handled in steel barrels for which a special form of truck has been provided as shown in the lower right hand corner of Fig. 11.

The cleaning and trimming room, Fig. 9, is equipped with five Waterbury-Farrel sprue cutters, seven double emery grinding stands, two band saws, a buffing stand and two core drill stands, together with three water mills and an automatic sandblast barrel furnished by the Hoevel Sandblast Machine Co., 40 Church street, New York. After the sprues are cut off and the castings properly cleaned, they pass to sorting tables where they are inspected and prepared for shipment or further manufacture. In general the operations in the cleaning and trimming department present no unusual features.

Steel Pattern Shelves

The pattern storage department occupies a 44-foot section of the west end of the service building, where it covers the entire three floors. Mezzanine floors, however, have been slung between the main floors so that the pattern storage section in reality comprises six floors in which over 36,000 patterns are stored and indexed. A standard card indexing system is used. Light, strong, steel shelving is employed. The stanchions are drilled so that the shelves may be set any required distance apart. The pattern-making department on the second floor is provided with modern equipment for the production of both wood and metal patterns. Facilities for making clay or plaster of paris models for ornamental work also are provided.

The general arrangement of the core room on the third floor is shown in Fig. 13. The benches are arranged along the walls on either side of the room as shown in the illustration, the core ovens being located in the southeast corner. The room is designed for the initial installation of equipment for the employment of 30 girls and 15 men at benches, together with six men on core machines. Space also is provided for a 48-inch sprocket core machine and for sand bins and a sand-mixing machine.

The plant is unusually well equipped with sanitary fixtures for the convenience of the workmen. Each man has an individual metallic locker which is well ventilated. There is a liberal number of shower baths and each workman has an individual wash basin. The basins are set up in batteries and are provided with hot and cold water. The toilet rooms are ample and well distributed. Also an artificially cooled drinking water system is provided with an abundance of fountains. A greenhouse 30 feet wide and 65½ feet long has been built on the roof of the service building and flowers are available throughout the winter. The greenhouse also provides plants which are set out in flower beds around the works during the proper seasons.

The plant is wired throughout for light and power, the main distributing boards being located in the entrance way. One distributing center is provided for power and another for light. From the power center four wire feeders are extended to the various motors. From the lighting centers three wire feeders are extended to panel boards located at various convenient points throughout the building.

From these panels the distribution circuits are extended directly to the lights. The main distribution boards are arranged with two sets of bus bars to take care of two-phase 220-volt 60-cycle current. The lighting feeders are three-wire throughout. This arrangement would make it possible to install a three-phase system of distribution over the same feeders if future requirements should demand a change of this nature.

Arrangements for Lighting

The lighting outlets are located in the ceiling and are arranged for general illumination. They are calculated for an intensity of not less than 3 lumens per square foot. In addition to the general lighting, circuits are extended to various points for individual lights on molders' benches and elsewhere if required. The fixtures consist of porcelain receptacles mounted directly on the outlet boxes. In the pattern storage department, they are provided with pull chain sockets; in the other departments they are controlled directly from the panel board.

All portions of the plant are protected against fire by a system of automatic sprinklers and small hose lines. The water supply consists of connections to a system of cast iron yard mains fed by elevated tanks and special pumps which are used exclusively for fire protection purposes.

The Yale & Towne brass foundry is operated under the general supervision of J. A. Horne, general superintendent, assisted by P. F. Augenbraun, superintendent, department of design, and M. F. O'Brien, foundry foreman. Chas. T. Main, Boston, acted as consulting engineer during the construction period.

Manufacture and Utility of Manganese Steel

A Discussion of the Valuable Properties of This Cast Product, With Instructions for Adding the Ferro-Manganese

By John M Hall

MANGANESE steel was discovered in the early 80's and was originally made by mixing molten ferro-manganese and carbonless bessemer-blown metal in such amounts as to give various proportions of manganese in the finished product. Consequently, the ratio of manganese to carbon was practically fixed. With less than a certain amount of manganese the metal proved extremely brittle and in practice the minimum content of manganese was about 9 per cent, the usual amounts being generally 10 to 14 per cent manganese and from 1 to 1½ per cent carbon. The silicon is usually from 0.2 to 0.5 per cent, the sulphur about 0.001 per cent and the phosphorus will average 0.08 to 0.1 per cent. Small variations of silicon and phosphorus have little effect upon the properties of manganese steel. The sulphur is low because the manganese eliminates it by flotation as manganese sulphide.

More recent researches have shown that if the carbon content of the steel is maintained at about 1 per cent, the metal will be austenitic after quenching even if the manganese content within which pure austenite can be obtained is narrow with low manganese content and widens as the manganese increases.

Low Conductivity

Manganese steel has a very low conductivity for both heat and the electric current, a low melting point (about 1,360 degrees Cent.), and a very high co-efficient of expansion which necessitates a shrinkage allowance of 5/16-inch to the foot for castings. The steel is practically non-magnetic in all ordinary conditions. When cast it is brittle and after heat-treating by heating to about 1,080 degrees Cent. and quenching, its tensile strength is only moderate, from 60,000 to 80,000 pounds per square inch, with a low elastic limit in both tension and compression and a rather high ductility; its shearing strength is remarkably high. When rolled or forged and treated, the tensile strength of manganese steel is increased greatly, sometimes reaching 150,000 pounds per square inch and the ductility is much improved, the other properties being not much altered. The rolled material, if it is not treated, is quite brittle.

Hardness of Manganese Steel

The metal owes its great usefulness to its hardness. In the heated state the hardness is of a peculiar kind. Owing to the low elastic limit, the metal can be made to pean or flow, when cold, under the blows of a hammer, to a considerable extent. In a way, therefore, the steel is soft and hardness tests which depended upon indenting the material, do not give high figures. Unless specially heat-treated, however, it cannot be cut with tools to a sufficient extent to make machining practicable and its resistance to most kinds of wear is extraordinarily great.

As the manganese content is reduced, if carbon be kept at the proper figure, the properties change much less than was originally supposed. The strength falls off a little, the toughness diminishes progressively and the magnetism increases a little. The resistance to wear is altered only slightly as long as the manganese is kept above 5 or 6 per cent, and the tendency to pean or flow decreases as the manganese content diminishes.

The usefulness of these low manganese steels is, however, limited by their lack of toughness; they are not very brittle, like the martensite steels of the same manganese content, but they are not nearly so tough as the steels containing over 10 per cent manganese.

Manganese steel is employed for the wearing parts of stone crushers and rolls working on hard rock, for the lips and teeth of steam shovels and ladder dredges handling rock or gravel, for centrifugal pump cases and flyers handling gritty water, for stone screens, coal cracking rolls, drive chains exposed to grit, etc. For railroad and trolley frogs, switch points, crossings, etc., the cast material is widely used and for rails laid on sharp curves manganese steel is almost indispensable. These rails were formerly all of cast material, but are now very generally rolled.

The tendency of the steel to flow or pean under heavy loads prevents its being used for railway car wheels. Under light loads in mine and quarry cars, blast furnace charging buggies, etc., it is widely used.

The simplest and cheapest way to produce manganese steel is to mix together molten 80 per cent ferro-manganese, and molten soft steel containing from 0.10 to 0.25 per cent carbon. The carbon content of the ferro-manganese brings up the steel to the correct composition as regards carbon. The steel is seldom made by the crucible process on account of the cost and the difficulty in obtaining low carbon steel by that method. The open-hearth furnace can be used to produce the soft steel required but the small bessemer converter has many advantages and is more widely used. It makes cheap metal, though not quite as cheap as the basic open hearth furnace; it produces small lots of metal distributed over the day and does not require running double turn and the cost of shutting down the plant for several days in the week is not nearly so high as with the open hearth furnace. The bessemer metal is not as good as the open hearth, because it is more highly oxidized, but the enormous addition of manganese will deoxidize it almost completely and most manganese steel castings do not require better metal than can be made in the bessemer converter.

Scrap Should be Remelted

The scrap produced, which may amount in small foundries to 40 or 50 per cent of the fluid metal, for complete economy must be remelted, which can be accomplished in the open hearth furnace, although, if only a single furnace is available and the chief product is manganese steel, the returned metal will produce a slag which cuts severely into the bottom of the furnace. In the small bottom-blow bessemer converter most of the scrap produced can be used by melting it with the pig iron in the cupola. The resulting high-manganese metal can be successfully blown by taking proper precautions, the practice being similar to that in the Swedish bessemer shops, when pig iron containing a high proportion of manganese is frequently

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blown. In the side-blow converter it has been found practically impossible to blow these high manganese mixtures. If the scrap is remelted in the open hearth furnace, or is remelted in the cupola and blown in the bessemer converter, all the manganese is oxidized and lost in the slag. The yearly loss represented by this oxidized manganese amounts to a considerable sum. The most obvious solution of this problem is to melt the scrap in the electric furnace, which can be done almost without loss of manganese. In practice, however, the saving, as compared with remelting and blowing is not very great, especially in shops already provided with a bessemer equipment sufficient for their requirements, because if an electric furnace is added to remelt the scrap, the output of the bessemer equipment is cut down and hence the cost of the steel is increased. For this reason the electric furnace has not so far proved so useful in the manufacture of manganese steel as its inventors hoped. To make electric steel cheaply it is necessary to use a furnace of considerable size and to keep it operating continuously. This is a condition not well suited to the average manufacturer of manganese steel castings.

Melting the Ferro-Manganese

As the ferro-manganese totals about one-fifth of the weight of the blown metal, it is essential that it be added in a molten condition and for many years, in spite of the expense of this method, the alloy has been melted in crucibles. The great advantage of crucible melting lies in the fact that the melting losses are relatively light. The cupola has been tried as a melting medium with more or less success, but the use of this cheap method is not general because the melting losses are very high with the best of precautions. The air furnace and the small open hearth furnace have also been tried but have not been adopted to any great extent for the same reason, and in the case of the open hearth furnaces, because night operation is not desirable in foundries. The electric furnace has often been suggested and has certain advantages in melting ferro-manganese as well as disadvantages, the most prominent among the latter being the high cost of installation and the loss consequent to having them idle at night.

In many cases it will not pay to install electric furnaces for melting ferro-manganese unless it is used at night for melting manganese steel scrap; this necessitates pouring off at night. When the capacity of the shops must be increased, it may pay in some cases to install electric furnaces.

The low melting point, greater shrinkage and greater fluidity of manganese steel introduces slight differences in molding practice as compared with ordinary steel. Its fluidity enables sound castings to be obtained with less shrinkage heads and risers than ordinary steel. Chills are extensively used and the heads often feed down to mere shells of metal. Cracked castings are common and the molds and cores frequently have to be broken up before the casting cools. To prevent the formation of cracks the castings are buried in sand or are placed in an annealing furnace where they are allowed to cool slowly. Manganese steel is heat-treated by being brought to 1,000 or 1,100 degrees Cent. and rapidly cooled in cold water. To prevent cracking, unevenness of section must be avoided as much as possible and the steel must be heated slowly.

Rolling and Forging

The rolling and forging of manganese steel is a difficult operation and for many years rolled shapes were made from a cast blank that approximated the shape of the finished product instead of from an ingot. At present large ingots are being successfully rolled into rails and other shapes. It is essential that the ingot be rolled or hammered lightly all over at first and it should be returned to the heating furnace before much reduction of size is attempted. The ingots are successfully brought to rolling temperatures which it was formerly thought could not be attained without risk of the ingots crumbling under the hammer. The range of temperatures under which the steel may be readily rolled is not very wide, since if it is heated too highly it will crumble, and if it is too cool, it will break the rolls. The heat treatment of the rolled steel is similar to that to which the cast material is subjected. Frequently, however, the shape is finished slightly above the proper temperature for quenching and is introduced into tanks of water without reheating. Uniform sections whether cast or rolled, can be made tough by cooling in the air, since the toughness is roughly a function of the rate of cooling.

Arc-Welding Applied to Foundry Work

By J F Lincoln

WELDING is the process of joining two pieces of metal of like or unlike character by melting them together at the point of contact. There are various methods of welding, in one of which the electric arc is employed. It is used merely as a method of applying heat at the point where it is desired and has no other utility. All metals, when brought in contact at a fusing temperature, will stick together with a strength which is practically equal to the original piece and it makes no difference whether these metals are heated by the use of the forge fire, electric arc, oxy-acetylene or any other method as long as they are applied when they are at a melting temperature with the surfaces clean so that intimate contact can take place.

The reason the electric arc is used extensively is entirely one of cost and convenience. There are other methods of applying the heat. The one which is most used is that of the forge fire in which the pieces to be welded are heated to a fusing temperature and then are applied at this temperature, supplemented by hammering to make the contact more intimate. The oxy-acetylene blow torch is also used and is entirely successful.

The electric arc may be applied to practically all metals which are to be welded. Several difficulties are encountered, notably, expansion and contraction which is apt to leave internal strains if not compensated for. This is self-evident since the pieces which are welded are heated at one spot only, the remainder being cool. It is evident, therefore, that when this spot cools, internal stresses will be set up. This difficulty is particularly marked in large pieces where only one spot is heated and where the metal itself is brittle such as cast iron, and also in certain shapes of steel. In order to eliminate this where necessary, pre-heating or annealing is employed. Annealing always is necessary in gray or malleable iron if machining is to be done on the weld when it is completed, since the chill at the point

of weld or the points immediately around it will result in a glass-hard surface.

A second difficulty which is encountered in welding is the formation of oxide. All welds are made at a temperature at which the metal oxidizes very rapidly and it is often necessary to float the oxide on the top of the weld in order to get the welded surfaces clean. However, with this method, good work can be done in all kinds of metal, the weld itself being entirely clean and free from oxide.

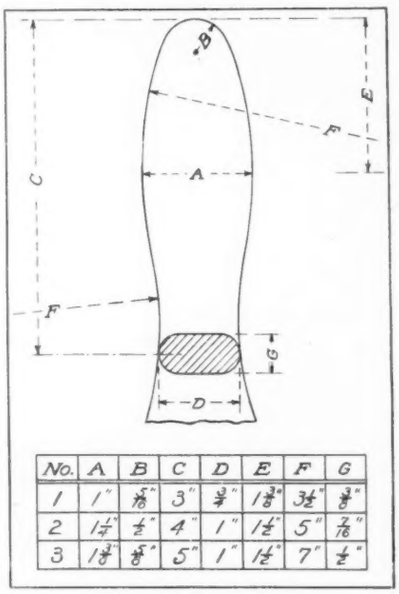
When the Arc Burns Through

Another difficulty which is often encountered in very thin metal results from the arc burning through. Where metal less than 18-inch gage is used, this necessitates backing up the weld with some good conductor that will carry the heat away and eliminate the possibility of burning through. Backing up with a piece of cast iron or steel usually will eliminate this difficulty.

Another vital point to be considered is the comparative speeds that it is possible to get by the use of various methods of welding. There are two methods of applying the arc and they have a large influence on the speed of operation. The first and easiest method of application is with an arc formed between the piece to be welded and a carbon electrode. In such a weld as this, the amount of heat which can be liberated is almost unlimited; therefore, the rapidity of melting is also great. In any steel casting or in some boiler plate, this method can be used and will result in a high speed of operation. For thin sheet metal the metallic electrode is employed. Usually it is a piece of soft steel which of itself becomes the filler and is melted off by the formation of the arc. This scheme has an advantage in that the heat will travel only a short distance away from the weld and the metal outside of the one spot where it is being welded remains at a low temperature, thus eliminating warping and internal stresses. The speed of spot welding, however, is not as high as it is possible to get by the use of the carbon arc, but it is favored on account of the fact that it eliminates warping and makes a softer weld than is possible with the carbon arc. It also eliminates almost entirely, all oxide in the weld. This method of welding is practically as fast, per foot of welding, as by the use of the oxy-acetylene torch, both being in the hands of skilled operators and both working to the best advantage.

Electric arc welding in its various applications is comparatively new and like any new process has been hedged about with a great deal of mystery which has resulted in a slow growth. The process is becoming increasingly popular, however, and is being rapidly adopted. When it is remembered that the one and only function of the electric arc is to furnish heat at the weld, a great deal of mystery is eliminated.

A number of different machines have been devised for arc welding. All of them tend to save part of the power which would be wasted if standard voltages were used with the arc. A piece of fence wire of proper size and length connected to any direct current source of electricity will do good welding. The principal function



No.	A	B	C	D	E	F	G
1	1"	5/16"	3"	3/4"	1 3/8"	3 1/2"	3/8"
2	1 1/4"	1/2"	4"	1"	1 1/2"	5"	7/16"
3	1 3/4"	5/8"	5"	1"	1 1/2"	7"	1/2"

PROPORTIONS OF THREE SIZES OF CAST LEVER HANDLES

of the welding machine, however, is to save the power which is wasted by using resistance in series with direct current to cut down the standard voltage. The potential across the arc in arc welding will vary from 15 to 50 volts depending on the length of the arc, the amount of current flowing and also the electrode used. It is evident, therefore, that if this current is taken from a 250-volt direct current supply, from 200 to 230 volts must be dissipated. Arc welding machines are divided roughly into two classes; one is known as the constant voltage machine and the other as the drooping characteristic machine. The ordinary, constant voltage machine includes a motor-generator set which will take current from the supply line at standard voltage and deliver it at 75 volts for the welding circuit. It is necessary, of course, to have a resistance in series with this 75-volt machine in order to get the potential down to the voltage required by the arc. A machine of this kind, however, generally is a good investment as it will show a considerable saving when continually used.

The other type of machine is designed to generate the exact voltage required at the arc. In other words, if the arc is short-circuited, the voltage will drop to zero and as the arc is drawn out, whatever potential is required across the arc will be the voltage of the machine. A machine of this kind, it is believed by the writer, will pay for itself within a short time after being placed in operation. Machines of both classes are manufactured at the present time.

Now let us see what the cost is on an arc of 150 amperes. Assume that the current costs 2 cents per kilowatt-hour and that the arc of 150 amperes is maintained continually. With a 250-volt supply and merely a resistance in series, the cost per hour will be 75 cents, as 37½ kilowatt-hours would be used. With the drooping characteristic machine the cost would be 9 cents per hour, as 4½ kilowatt-hours would be used; or, putting it another way, if a resistance is used in series with the 250-volt line, it will take approximately four months to waste enough current to pay for a drooping characteristic welder.

Proportions of Cast Lever Handles

By John Leafstrom

The accompanying table and illustration give proportions of three sizes of cast lever handles, which are proportional to both large and small machine levers. These dimensions will be found to be valuable in laying-out patterns as occasionally the detailed drawing gives only the diameter of the handle, making the general shape, length, etc., a matter of judgment. In shops where machine levers are being constantly made a set of standard templates made to these dimensions will facilitate marking off the patterns.

Combination Gaiter and Legging

The William H. Horstmann Co., Fifth and Cherry streets, Philadelphia, has patented a leg and foot protector for use in foundries, which is said to completely resist the burning action of molten iron. These protectors are used extensively by ladlemen and others connected with the melting department. The protector consists of a combination gaiter and legging, which is held to the leg by bicycle clamps in such a manner that it may be instantly removed if necessary. The legging closes with a lap at the back, which is held secure by glove fasteners.

The Manufacture and Uses of Malleable Iron

The Characteristics of Malleables Are Discussed, With Pertinent Suggestions for Making This Class of Material

By J P Pero

WE UNDOUBTEDLY owe to the great Frenchman, Reaumur, the information we now possess on the softening of cast iron. In 1722, he states, in regard to the softening of cast iron, that heating iron castings embedded in red oxide of iron softens the metal much more rapidly than any other method which he had tried. This, we believe, was the first information regarding the production of material similar to that now called malleable iron. In 1804, an Englishman, Samuel Lucas, in some way was able to obtain a patent on the process and the industry practically begins from that date. In this country Seth Boyden began using this process in Newark, N. J., in 1826. In 1828, the Franklin Institute offered a medal for the best piece of annealed cast iron, the pieces to be twelve in number, and the medal was awarded to Boyden. Thus began the manufacture of so-called malleable iron in the United States.

Notwithstanding the fact that the industry in this country therefore, is less than a century old, it has grown to enormous proportions, there being now in the United States about 250 different firms producing malleable iron and turning out a total output approximating 1,000,000 tons per year. For some reason the industry is almost exclusively an American one, malleable iron being manufactured in Europe only on a limited scale, its use over there being confined principally to light, intricate castings, although there are a few notable exceptions in which European practice is similar to that of this country.

Rapid Growth of Industry

The malleable iron industry has made its most rapid growth in this country in the past 20 years, during which time it has almost entirely replaced the use of cast iron, in freight car construction and in the manufacture of agricultural implements. It is now also being used extensively in the manufacture of automobiles, in stoves and ranges and countless other industries. The difference between malleable iron and cast iron is due to the difference in the proportions of the various chemical elements and to the heat-treatment given malleable iron in annealing. In the manufacture of malleable iron, the first essential is to secure the proper grade of pig iron, the analysis of which will have to vary more or less with the nature of the work whether heavy or light.

Presented at the Chicago, 1914, convention of the American Foundrymen's Association.

How the Iron is Melted

This iron, with the desired percentage of sprue and scrap, is charged into the air furnace and melted with any high-grade coal which is low in sulphur and will carry a long hot flame. When the metal is in the molten state, a test is made to determine whether a sufficient amount of silicon and carbon has been oxidized-out to produce a white iron casting, for it is essential to the manufacturer of good malleable iron castings that none of the carbon appear in the castings in the graphitic form, but that the castings be a perfect white and free from any mottle.

Owing to the lower carbon and lower silicon content of the malleable mixture, the melting point is considerably higher than that of cast iron and as the lower carbon, silicon, phosphorus and manganese content makes malleable iron less fluid than gray iron, the metal must be poured much more rapidly and at a higher temperature, requiring greater skill on the part of the molder, to prevent misruns and to avoid washing or blowing due to the rapid influx of the metal.

The use of the cupola in the manufacture of malleable iron castings is practically obsolete, being used only in a very few shops making the lightest kind of castings, the cupola having been replaced almost entirely by the air furnace and in some few shops by the open-hearth furnace. The use of the cupola was abandoned because of the uncertainty in the results obtained, although the cost of melting, both as far as fuel consumption and maintenance are concerned, is much lower in the cupola than in either the open-hearth or air furnaces.

Owing to the fact that malleable iron runs lower in silicon, phosphorus and manganese than gray iron, it is much more liable to shrink and crack than gray iron. The initial contraction in a malleable iron casting is about double that of cast iron, averaging about ¼ inch to the foot. On this account, great care must be exercised to avoid shrinkage flaws in castings, due to unequal cooling of the casting. An expansion of about ⅛ inch to the foot occurs in annealing malleable iron, so that in making patterns for malleable castings, the same shrinkage rule is used as for patterns for cast iron work.

The gating must be entirely different and, as a rule, it is a good plan to have the malleable iron foundry which is to furnish the castings gate the patterns.

Do not confound the terms *shrinkage* and *contraction* as used in this description. *Contraction* is the term used to designate the difference in dimensions between the pattern and casting, while the term *shrinkage* is intended to designate the drawing away of the fluid iron from the heavier section by the lighter sections, due to the lighter sections solidifying more quickly than the heavier and naturally drawing or feeding from the more fluid iron in the heavier section.

Cracking is caused by strains which are caused by unequal expansion and contraction and is frequently due to abrupt changes and even to slight changes in sections. The cracks generally show when the casting is taken from the sand, but frequently the castings show no crack until after annealing, indicating that the shrinkage strain existed originally, but was latent until acted upon either by expansion under heat of annealing or contraction during the cooling process of annealing.

Avoiding Shrinkage

Shrinkage flaws can best be avoided by designing the castings of as nearly uniform sections as possible. Abrupt changes of section should be carefully avoided, but where such changes in section cannot be avoided, shrinkage may be overcome by the use of chills on the heavy sections, which tend to accelerate the cooling of the heavy section, and in this manner bring about a more uniform solidifying and cooling of the varying sec-

tions. Shrinkage also is overcome by gating on the light sections as close as possible to the point at which the heavy and the light sections join. The gates should be supplied with shrink balls sufficiently heavy to feed the shrinkage. Care should be taken to gate into the light section rather than the heavy, for then the gate and shrink ball will serve the double purpose of feeding the shrinkage, occurring first in the light section, which would otherwise be drawn from the heavy, and also retarding the solidification and cooling of the light section, in order to have these actions more nearly simultaneous in both the heavy and the light sections.

After the castings have been poured, they are broken from the gates in the usual manner and sent to the cleaning room where the sand is removed by tumbling, and in cases where the castings are too frail to permit of being tumbled, the sand is removed from them with a sand-blast or by pickling the castings in a solution of sulphuric acid.

When the sand has been removed, the castings are inspected and fettled, by which term we mean that any projecting fins, gates or rough places are chipped off with a hammer which can be readily done while the castings are still in the hard iron state.

The Annealing Process

The good castings are then sent to the annealing room where they are packed in annealing pots which consist of a heavy, malleable iron frame usually about 18 x 24 inches and 12 inches deep, these frames or rings being placed, one upon the other, as they are filled until the tier of pots or frames is from 4 to 6 feet high. In these rings the castings are carefully packed, to prevent warping during the annealing process. The spaces between the castings are filled with a packing, consisting usually of rolling mill scale or crushed slag, but generally a mixture of both these materials. The joints in the rings and the tops are then carefully luted-up with clay to exclude the air from the castings. The pots are then trucked from the packing floor to the ovens, the oven doors are walled up and the ovens are fired until the pots show a bright red heat, the proper annealing temperature being between 1,300 and 1,500 degrees Fahr. After this temperature has been obtained in all parts of the oven, the drafts are closed and the oven is permitted to soak, the annealing temperature being maintained for about 72 hours. The oven is then cooled as slowly as possible and when the pots are black, they are removed and dumped, each potful of castings being thoroughly tested to see that the castings have been subjected to the proper temperature, and are properly annealed before being sent to the soft iron tumbling room where they are again tumbled.

The time consumed from the time the castings are placed in the oven until they are ready to be taken out will vary with the size of the ovens, but usually averages from about four to eight days.

Until recently it was considered absolutely necessary to use an iron oxide as packing; in fact, malleable foundries were put to considerable expense in buying mill scale for this purpose, and a few years ago it was common practice to spread the packing thinly over the floor and sprinkle it with a solution of sal-ammoniac, which caused it to rust quickly, thus furnishing the oxide considered necessary.

Use of Slag

A common practice now is to use the slag obtained from the skimmings of the melting furnaces, which is washed and ground in a wet tumbling barrel, to obtain the shot iron mixed with it in the skimming process. This material is frequently used alone as packing, but sometimes is mixed with mill scale. Some foundries are using sand as packing and still others are annealing in muffled ovens without either pots or packing of any kind.

After being tumbled, any castings which have become badly distorted in the annealing ovens are straightened, either by hand or under the drop hammer. In some cases, the fins are ground and the finished castings sent to the shipping room for distribution to the customer.

A satisfactory quality of malleable iron should show a tensile strength of from 35,000 to 55,000 pounds and in some cases, 60,000 pounds per square inch, with an elongation of from 3 to 8 per cent in 2 inches.

The greatest advantage of malleable iron is the fact that the metal is not subject to crystallization or fatigue, but will stand as severe a test after 20 or 25 years of use as it will when originally made, no matter how great the vibration may have been to which it has been subjected.

If proper care is used in its manufacture, it should also be quite free from internal flaws, such as blow-holes or shrinkage flaws, and the metal, while it will stand considerable abuse and distortion before breaking, is much more rigid and will resist the tendency to become distorted to a greater extent than either drop forgings or steel castings of the same sections.

Malleable iron also resists rusting or corrosion very much better than either wrought iron and steel, running only slightly below cast iron in its resisting qualities to oxidation.

There is a widely prevailing belief that malleable iron can be annealed only in light sections and that when sections over ⅜-inch in thickness are required, difficulty will be experienced in properly annealing it. The facts are that there is no limit to which malleable iron can be annealed, providing the manufacturer has used the proper care in handling his mixture, to insure the casting being free from mottles of graphitic carbon in the hard iron state.

Owing to the fact that the heavy sections cool more slowly than the lighter, the metal for heavy castings must run lower in silicon and carbon to retain all the carbon in the combined form in the heavy sections. When this is done, the metal becomes less fluid and is increasingly difficult to pour into light work and for that reason, it is not practical for the manufacturer of malleable castings to make both heavy and light castings from the same mixture, but where a specialty is made of heavy castings, or where the mixture is run especially for heavy work, no difficulty need be or will be encountered in annealing the castings through and through, as all that is necessary to anneal them is to bring the castings up to the proper temperature, in which no difficulty is experienced as it is manifest that when the annealing pots, which are usually 18 to 24 inches in thickness, are heated through, a heavy casting will be heated through just as readily as a lighter one.

Changes During Annealing

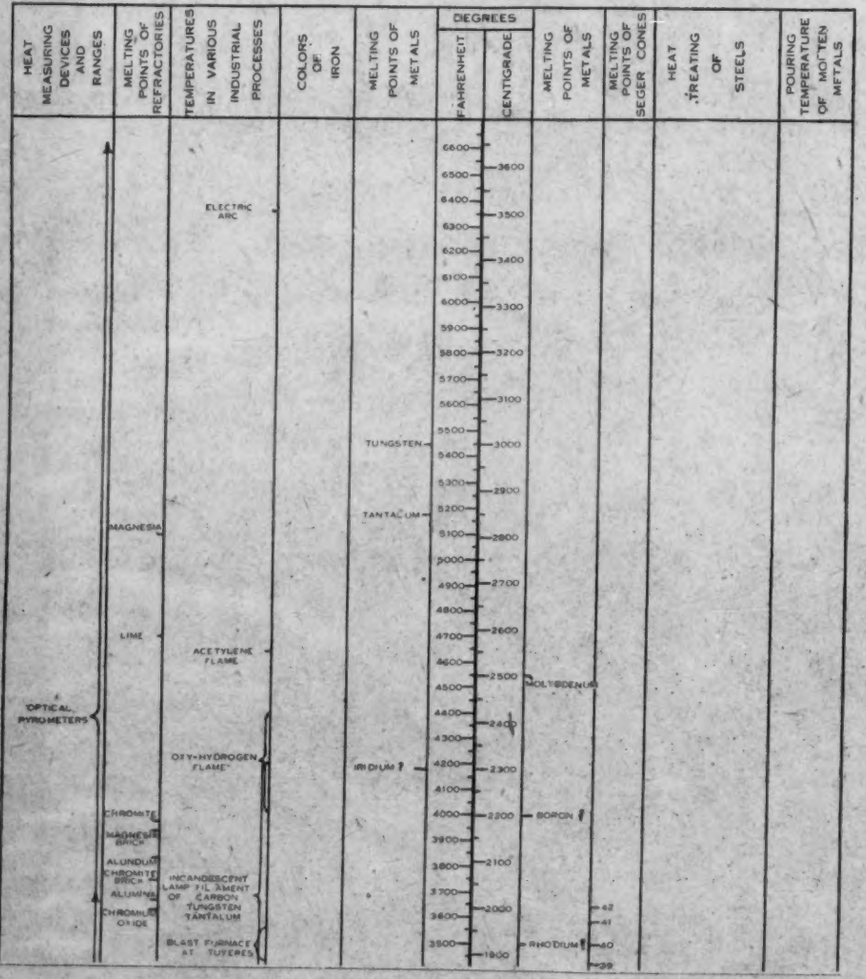
What occurs in the annealing process is not so much a chemical change as a change in the nature of the carbon. A small amount of carbon, it is true, is oxidized from the surface of the casting, but most of it is changed to the graphitic form. Examined under a microscope, the little particles of graphite will appear surrounded by and contained within cells of pure iron. The structure of the cells is not broken by these little particles of carbon, as it is in cast iron, where the graphite is in the shape of a crystal, breaking up the cells of pure iron and weakening the structure.

The cells of iron within which the particles of graphite are contained are practically wrought iron or rather steel, as a small percentage of the

METALLURGICAL TEMPERATURE CHART

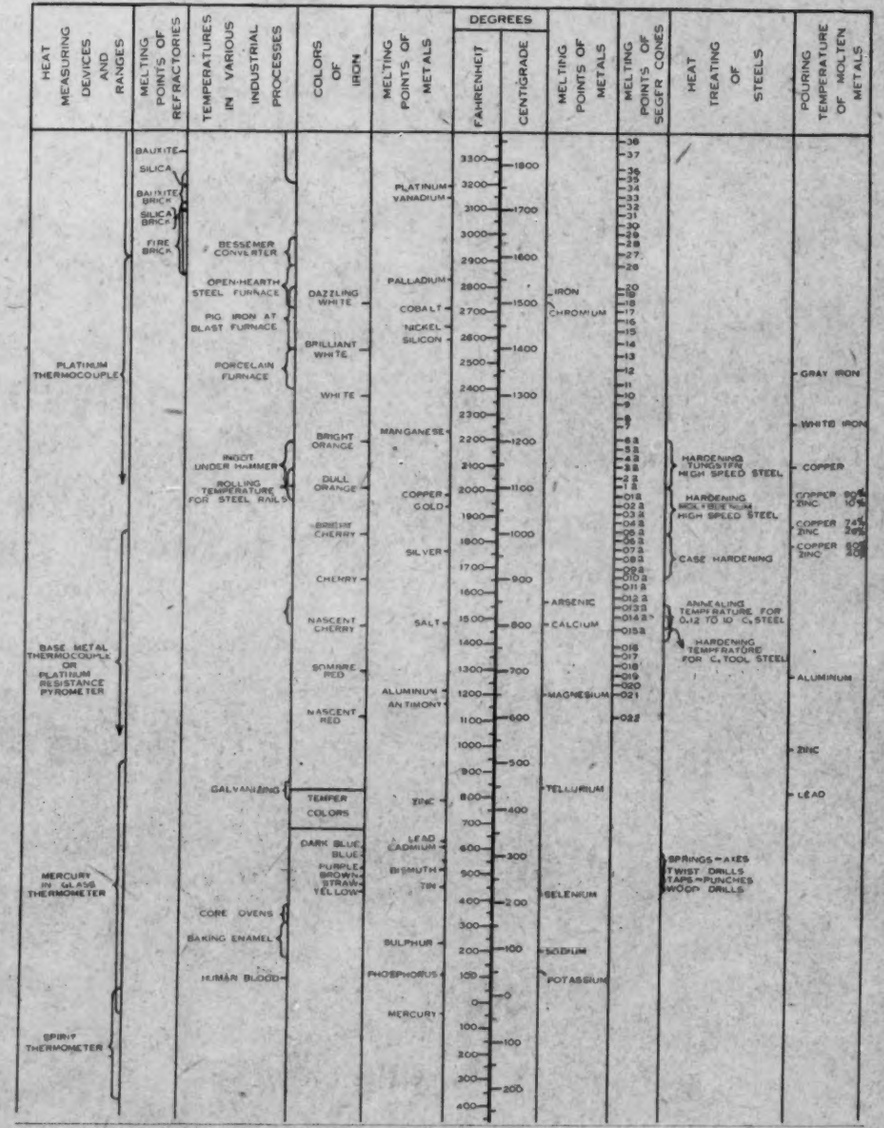
By William J. Kiln

These scales may be clipped apart and pasted together to form a continuous chart of metallurgical phenomena from 400 to 6,600 degrees Fahr. Both Fahrenheit and Centigrade scales are presented, together with the melting points of metals, heat treating data and other information.



DATA SHEET No. 183, THE FOUNDRY, APRIL, 1915.

METALLURGICAL TEMPERATURE CHART



DATA SHEET No. 184, THE FOUNDRY, APRIL, 1915.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

THE FOUNDRY DATA SHEET, APRIL, 1915

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

carbon will still be left in the combined form. This accounts for the great strength as well as the stiffness of malleable iron.

The graphite contained within the cells gives malleable iron when broken a bluish black color. A thin section of a lighter color will usually appear around the edge. This skin should not be much thicker than a finger nail and is caused by the fact that on the surface of the casting the carbon has been almost entirely removed, having been oxidized-out by the oxide of iron used as a packing in the annealing process with which the castings were in contact while being annealed.

There is a widespread belief that this bright rim around the outer edge of malleable castings indicates the depth to which it is has been annealed, but such is not the case; in fact, where this bright edge is too heavy, it is often an indication of poor iron which has been over-oxidized in either the melting or annealing process.

As previously stated, it is important in designing a casting for malleable iron to keep the distribution of metal of as nearly uniform thickness as possible, relying upon ribs to give added strength where additional strength is required.

If the consumers of malleable iron castings would co-operate a little more closely with the malleable iron foundrymen in the designing of their castings, much good would be accomplished, as frequently the failure of malleable iron castings is largely due to improper design, causing shrinkage flaws or undue strains which have weakened the castings. Co-operation of this kind not only would result in better castings, but in cheaper sections, as it would, in a large measure, obviate one of the principal sources of loss in the malleable iron foundry, due to cracked castings, cracking being caused by unequal strains while cooling in the mold.

A great deal has been said and written in the past few years regarding specifications for malleable iron castings and a great many of the railroad companies, particularly, are now making rigid specifications as to tensile strength and elongation, etc., specifying in numerous instances that one casting in every 100 shall be furnished by the manufacturer for test purposes and that, if desired, the purchaser may cut a test piece from the casting which shall come up to certain requirements as to tensile strength and elongation.

Any piece of malleable iron which has been well-annealed will readily come up to specifications as to tensile strength and elongation. The essential point is to determine whether the castings have been thoroughly annealed. An annealing potfull of castings may contain castings from half a dozen different heats which in turn may require as many different temperatures to properly anneal. Again, it is difficult to get the heat uniformly distributed throughout the annealing oven. It is not uncommon, therefore, in malleable practice to find two castings, lying side by side in the annealing pot, one of which is thoroughly annealed and the other still brittle, hard and unfit for use. It also is not an uncommon occurrence to find a malleable iron casting 2 or 3 feet in length, one end of which is thoroughly annealed while the other end is still brittle and unfit for use.

Any specifications, therefore, which rely upon the testing of only an occasional piece will not give the consumer of malleable iron the necessary safeguard. By far the best precaution is to have a test lug cast upon every piece, which can be broken to determine whether the malleable casting is thoroughly annealed without in any way injuring or destroying the efficiency of the casting.

Castings of large size or of any unusual length should have at least two test lugs on them, and, in exceptional cases, three test lugs might be desirable.

Some of the railroad companies have begun to recognize this fact and today are specifying merely that castings shall be true to pattern, free from shrinkage flaws and other defects, with a test lug cast upon every casting at a point where it will not interfere with fitting points, and that the test lug when broken shall show a good quality of malleable iron thoroughly annealed. This is the test prescribed also by practically all of the railway specialty companies that have probably given the use of malleable iron more careful study than any other class of consumers.

Making Cores for an Intricate Casting

By J L Sendner

THE TWO illustrations presented herewith show a method of making the pattern and cores for an intricate casting for a high pressure testing pump. The sticks and twine shown in Fig. 1 were used to hold the core in the position they occupy when in the mold. The job was made in a two-part flask, the flanges on the cope side, shown at *A*, Fig. 2, being formed by cover cores.

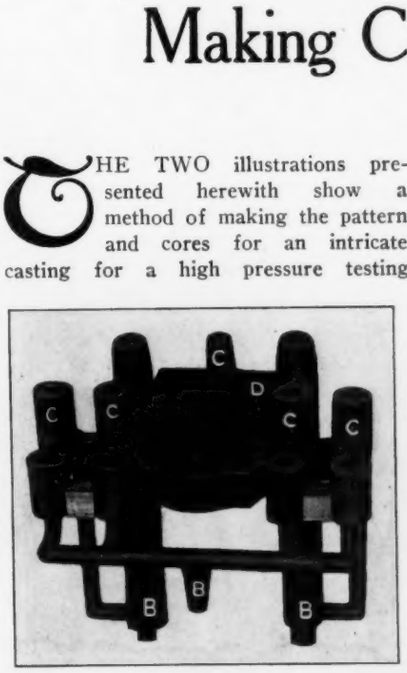


FIG. 1—CORES ASSEMBLED IN PROPER RELATIVE POSITION

To forestall any possibility of leaks developing in the casting, it was decided at the start not to use any chaplets or anchors. To accomplish this it was advisable to have as few separate cores as possible. When the cores came in contact with one another they were joined by means of tapered prints. The core boxes were of the one piece or solid type, which eliminated jointing and pasting and prevented metal from entering into the vents.

The assembled core consisted of seven individual parts, five of which were joined when baked by means of prints to make the complete core *B*, Fig 1. Cores *C* and *D* are separate cores and were suspended from the cope. The several parts forming the core *B*, after being securely pasted into their respec-

FIG. 2—PATTERN SHOWING FLANGES MADE WITH COVER CORES

tive prints were returned to oven where the paste was allowed to set thoroughly. It was necessary to maintain the proper relative positions of the several parts of the core while the paste was drying in the oven. This could be done by means of a skeleton frame or jig and if the casting had been a large one, such a method probably would have been employed. This particular casting was made in a 36-inch square flask so instead of using a jig, the drag half of the pattern was rammed up on the jarring machine. After the pattern was removed, the mold was sprayed with molasses water and placed in an oven to dry. When thoroughly dried, it was taken from the oven and some of the cores were placed in their proper core prints. The others were pasted into their respective positions and small blocks of wood were placed in various places between the core and mold, wedging the cores into their proper places and leaving the desired thickness for metal. The mold and core were now returned to the oven and when the paste was thoroughly set the entire core was removed and placed in its proper mold.

The master mold used in assembling the cores was made of core sand, instead of molding sand. It was carefully dried with a very hard, firm surface, to allow for blocking and wedging the cores into their places without danger of pressing the wedges into the sand. We did not use the master mold as part of the finished mold, as there was danger of breakage in fitting and blocking cores that would take considerable time to patch. Only ten minutes was spent making the master mold, there being no venting or securing to provide for.

No trouble was experienced in setting the cores or pouring the mold. The casting machined up nicely and later successfully stood a hydraulic test of 1,200 pounds per square inch. Had we been obliged to make a large number of these castings, this method could have been improved, but only at considerable expense. As there was but one casting ordered, we avoided the use of expensive drying shells and the danger of leaks from several anchors and chaplets.

Safety in Tumbling Mill Operations

SAFETY in cleaning room operations is discussed in a bulletin issued by the committee on safety and sanitation of the National Founders' Association. It is stated that in cleaning rough castings by the use of dry tumbling mills or tumbling barrels, large quantities of dust are created. This dust must be properly taken care of so that it may not produce an injurious effect upon the health of employes working about these machines. In addition, tumbling mills must be provided with appropriate safeguards to overcome mechanical dangers incident to their operation and use.

The physical condition of the foundry and the construction of the tumbling mills themselves will largely determine how best to solve the dust problem. One of two methods will be found applicable to all cases. A suitable exhaust system may be employed to carry off the dust, or each machine may be enclosed in a separate dust-proof compartment. The use of an exhaust system is most desirable, as it carries the dust away from the machine to a place outside of the building; exhaust systems, however, can be installed only upon mills which have been expressly built for exhaust connection.

Dust-Proof Compartments

If the machines are of the non-exhaust type, the dust danger can be averted by providing dust-proof compartments in which the mills can be entirely enclosed while in operation. When the mill is located away from partitions or walls, or where a high compartment would interfere with proper lighting of the workshop or consume head-room valuable for other purposes, these compartments are built only high enough to accommodate the machine; otherwise they are usually built against existing walls or partitions right up to the ceiling,

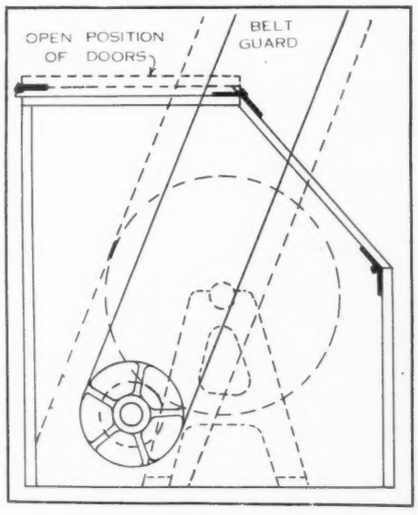


FIG. 1—TUMBLING MILL IN DUST-PROOF BOX

thereby increasing the air space within the compartment and facilitating the settling of the dust. For small compartments, the doors may be arranged to fold upward and lie upon the top of the compartment when the mill is at rest; for most machines, however, the size and weight of the doors will require that they be suspended on rolling door-hangers. They may then slide horizontally if there is ample slide room, or vertically if side space is limited. Steel rolling shutters are sometimes used instead of rising doors. The whole compartment should be tightly built of well-seasoned lumber to prevent excessive shrinkage and warping; the doors should be well fitted to insure fairly tight joints and ease of operation. Rising doors, to avoid falling upon workmen, must be carefully counterweighted, or provided with a suitable automatic latch, or both.

While, obviously, there is no dust problem in the operation of wet tumbling mills, the mechanical hazards of both wet and dry mills must be guarded against, unless the mills are enclosed in dust-proof compartments during their operation, in which case only external belts or driving chains may need to be covered by appropriate guards.

Dangers to be Avoided

When not enclosed, tumbling mills present mechanical hazards which may lead to serious consequences. The corners of square box tumblers, or protruding fastenings or flanges on round or stave type mills, or even nails, slivers or core-rods which may work through perforated or losely fitting cover plates, are apt to strike the workman or catch in his clothing. Exposed gears, belts and driving chains are additional potential sources of accidental injury. With a comparatively small expenditure, however, all of these dangers may be effectually safeguarded.

Although the workman's personal caution and watchfulness is always his own most effective protection, the mill itself should nevertheless be so guarded that the workman may not easily come into contact with it while it is running. Suitable guard rails or fences, made of pipe, heavy wire

screen, or wood, erected at the exposed sides of the tumbling machines and provided with a rising screen gate in front, will prevent contact of workmen with the machine when it is in motion. Where rising gates may not be practicable, suitable doors may be arranged to slide horizontally, or removable wire screen guards, fitting into pipe-rail sockets, may be used.

An automatic connection between the gate and the operating lever of the machine, whereby the opening of the gate will stop the machine, or the starting of the machine will close the gate, will render the machine inoperative when workmen are engaged in loading or unloading the barrel, and will keep workmen at a safe distance when the machine is running. In any event, whether controlled by gates or otherwise, such levers should be of the positive locking type, to prevent the levers from creeping over and starting the machine prematurely.

Observation and study of accident reports show that workmen's fingers and knuckles are often injured when they remove or replace tumbling mill covers by hand; and many foot injuries are traceable to the falling of such covers upon the workmen's feet. A light chain hoist suspended from a short trolley track above the chain and equipped with hooks to fit the cover handles, will tend to prevent such accidents and at the same time facilitate the work. The hoist may also be used to load and unload heavy castings in and out of the mill.

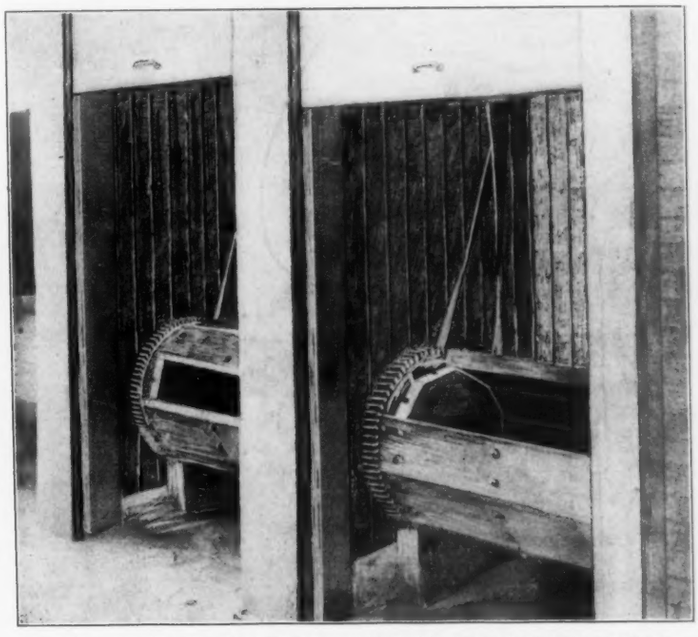


FIG. 2—TUMBLING MILLS ENCLOSED BY SLIDING DOORS

To prevent accidents caused by a slight movement of the mill while it is being loaded or unloaded, a suitable locking device or brake should positively lock the barrel in position; each foundry foreman can devise an effective brake to suit the conditions peculiar to his own equipment. The usual method of propping the barrel in place with a bar is not reliable, as it is apt to be kicked or jarred out of place. Finally, foremen and workmen should see that clear passageways are maintained in front of the tumbling mills.

In the nature of their construction and operation, tumbling mills present problems of safety and sanitation which require some thought for their solution, yet proper attention to the matter will develop effectual guards against the inherent dangers of tumbling mill operation, and at the same time the cleaning room can be made a reasonably attractive workshop.

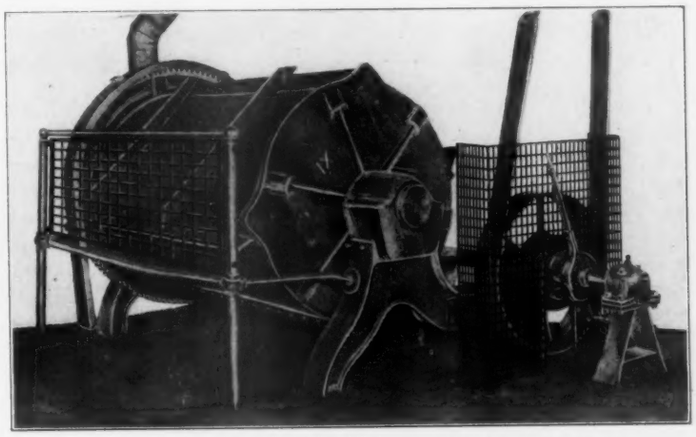


FIG. 3—WIRE GUARDS AROUND TUMBLING MILL

Putting One Over on the Foundry

By H. D. Murphy.

Our plant operates its own foundry as well as machine shop and a large part of the work consists of valves and fittings for gas and must stand considerable pressure. For some time the reports of the testing department have been showing anywhere from 25 to 50 per cent leakages on the first test. This was altogether beyond reason even though it was somewhat offset by the fact that a number of these could be fixed up and finally be sent out for service

The foundry foreman received copies of the reports and tried one experiment after another without success. Neither changes in formula nor methods of molding would bring satisfactory results. Matters eventually reached the stage where the trouble had to be eradicated or the marketing of the fittings abandoned, as competition would not permit manufacturing at any such loss.

Just about the time this decision was reached, however, there occurred a slack time and the testing force was reduced to one man. Since then the loss on these particular valves has not exceeded 10 per cent and more than one lot has gone through 100 per cent good, without change in the foundry practice. An investigation was made and the evidence clearly indicates that the man who formerly tested these fittings, and who was one of those laid off, regularly put some aside as defective and went over them again and again and by this method make work for himself.

At present the foundry foreman is happy and the management is happy, but the machine shop foreman rather feels as if he had slipped up somewhere. If the former tester again applies for work I doubt if he will be employed. It is curious what can be put over on the foundry—sometimes.

How to Eliminate Defects in Steel Castings

Suggestions Are Given for Preventing Pipes and Contraction Cavities, Cracks, Internal Blow-Holes, Sand-Holes and Surface Imperfections

By John Howe Hall

THE STEEL foundryman has to guard against imperfections in his castings of several distinct types, which for convenience may be divided into the following classes:

1.—Pipes and other cavities due to contraction of the steel and formed chiefly during solidification.

2.—Stresses set up and cracks formed by contraction of the steel in the solid or semi-solid state.

3.—Internal blow-holes.

4.—Surface blow-holes, sand-holes and other exterior imperfections.

These imperfections must be prevented with the minimum loss of metal scrapped as sink heads, gates and runners. This paper is an attempt to set forth the principles that govern the methods commonly used to prevent the occurrence of these imperfections. Our metallurgists have not, up to the present time, studied these general principles so thoroughly as they have the proper methods to pursue in making steel of good quality; or, if they have done so they have not often published the results of their cogitations. There is, perhaps, a feeling among some of them that their proper sphere is the production of good fluid steel in the ladle and the heat treatment of the solidified castings, and that the production of sound castings is a simple matter that the molders should be able to attend to themselves. Since the phenomena of the contraction of steel in solidifying and cooling are far from simple, it is plain on a little reflection that the expert should pay attention to the molding and pouring, equally with the steel making and annealing. Indeed, the metallurgist who realizes, for instance, that some blow-holes are due to gassy steel and some to bad molding practice, and who is being held responsible by his superiors for all spongy castings on the score of "poor steel," is soon forced in self-defense to give his most careful attention to the subject.

Pipes and solidification cavities may be defined as cavities due to contraction of the steel and formed chiefly during solidification. It has not yet been definitely established whether steel actually expands or contracts at the moment of solidification. In a most careful exposition of the subject of piping in steel ingots, however, Prof. Henry M. Howe has shown that whether the steel contracts or expands in solidifying, the inevitable result of the comparatively rapid cooling of a mass of steel like an ingot is that the liquid metal in the interior fails to fill the first-frozen shell by progressively increasing amounts, and so sinks more and more as the ingot-walls thicken, producing the well-known "pipe."

One application of Professor Howe's methods of decreasing the depth of the pipe, which is utilized in ingot practice is to strip the ingots while their interior is still molten and charge them on end in the soaking pits, where their final solidification takes place slowly. The effect of this is that the metal solidifying upon the walls of the ingot has the greatest possible opportunity to slide down and fill the lower portion of the pipe, so that ingots handled in this manner do not pipe as deeply as when allowed to solidify in the molds.

In some cases it might be possible to accomplish a similar result by shaking out a casting before it is entirely solidified and charging it into a hot furnace where it is kept on end and allowed to complete its solidification slowly. By this method of handling, the metal in the sink heads would slide down to such an extent that the total amount of metal fed by a head of given size would be increased, so that a smaller head would be sufficient to do the work. The difficulty of so handling a casting, however, would in most cases prevent the use of this method. A modification of it, however, might be used for very large castings. Thus the heads and possibly a portion of the heavy upper parts of such a casting might be kept hot by removing the mold from around them and surrounding them with a brick-lined stove that could be put in position quickly and kept hot by means of oil burners or a coal fire. This method, indeed, is used to a certain extent when we heat the top of a sink-head with oil burners or a charcoal fire. Another way of accomplishing the same result is to use thermit in the heads in order to warm them up by the heat of the thermit reaction. Theoretically, the best way to fill a casting is from the top, straight down the sink-head, filling the top slowly. The heavier sections should be above the lighter, that the top may freeze last and feed the bottom: in some cases the bottom sections should be poured in chills, and there should be extra metal above the casting proper in the form of a sink-head, to feed the contraction of the upper portions. By such a method of pouring we should use all the available means for obtaining sound ingots. The stream of metal falling into the mold, however, would necessarily cut the sand so badly as to ruin the casting; or if cores intervened, they would be destroyed. Hence, we are compelled in the majority of cases to take the metal down a runner exterior to the casting itself, and into the casting by means of gates at or near the bottom. By dishing out the bottom of the runner and "nailing" the part so

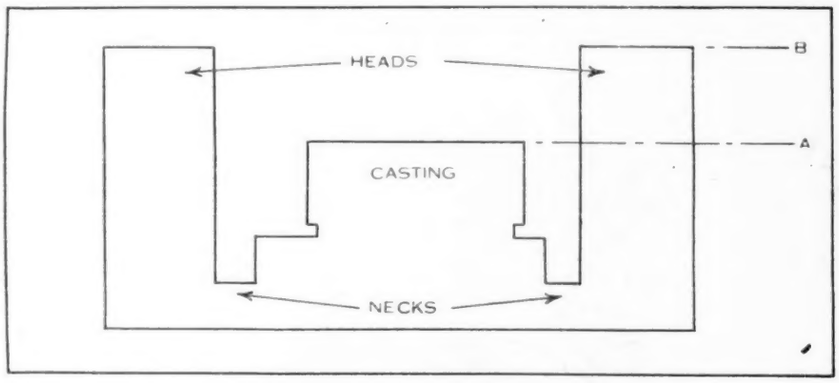


FIG. 1—HEADS IMPROPERLY PLACED ON A STEEL CASTING

Portions of a paper read at the Chicago meeting of the American Foundrymen's Association.

dished, we provide a basin whence the metal can enter the mold quietly and without cutting the sand, or spattering in such a way as to lead to surface imperfections.

Our molds, therefore, are commonly filled from the bottom, so that the metal which finally forms the top of the casting is that which first entered the mold and is the coldest. In most cases it is the only way to do the pouring. True, it is quite common to stop pouring through the gate when the metal reaches the sink-heads, and pour the latter from the top, and this practice is theoretically correct. But in some cases this is not sufficient, as the cooling of the upper part of a tall casting may outrun that of the bottom portions, poured last, to such an extent as to make it impossible for the feeding of the sink-heads to be effective. We may easily imagine a case where the top metal is so cold when pouring stops that it freezes completely, forming only its own small pipe. The sink-head will feed this; but the later-freezing lower portions will form their own contradiction-cavity, which is completely bridged off from the sink-head by the frozen upper portions.

This condition may often be met by arranging a series of gates at several levels, so that as soon as the mold and runner are filled up to the level of gate two (counting from the bottom) the metal will enter the mold through this gate and run in over that already in the mold. When the steel reaches the level of gate three, the process will be repeated. In this way we attain the advantages of top pouring, at least in part, by pouring in a series of sections; each section as it were acting as sink-

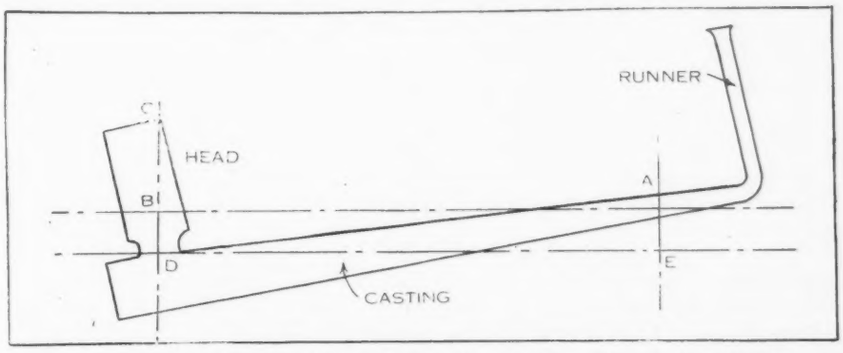


FIG. 2—HEAD IMPROPERLY PLACED AT LOWER END OF A CASTING

head for the part below, and the sink-head proper feeding the last section poured. This is the first advantage of the use of gates at several levels. We shall again refer to the subject and mention the second advantage, in discussing the question of the size of gates and runners.

There are certain disadvantages of this method, which may in some cases prevent its use. The first is that any loose sand from the mold, which ordinarily floats upon the steel as the mold is filled, and hence is carried upward to the sink-head, where it can do no harm, may be trapped in the casting when the metal begins to flow in through the upper gates. The second is the danger of filling the runner too quickly, so that metal will flow through the second gate before the metal in the casting has reached that level, and cut out the mold as it flows down its walls. These disadvantages, however, are in many cases neither insurmountable nor prohibitive.

How Chills Reinforce the Action of Sink-Heads

To return to the subject of chills from the standpoint of their first function, that of decreasing the size of shrinkage cavities. The laws laid down by Professor Howe show us that if we pour the bottom third of a casting, for instance, in heavy chills, we give to that third of the casting the maximum tendency to pipe,—since piping is the more pronounced the more the rate of cooling of the outer layers outstrips that of the inner during the first period of cooling, and heavy chills favor this condition. We thus cause the bottom third of the casting to pipe deeply, and since its cooling as a whole will be rapid, to pipe early. If this early and deep piping can be made to begin while metal is still being run in through the gate, that fresh metal will partly fill the cavity while pouring is still in progress; thus part, at least, of the object sought, the feeding of the casting, takes place during pouring.

In certain cases where the vertical height of the casting is small, compared to that of the runner, and no separate sink-head is used, the runner itself may be considerd as the sink-head. In this case, the action of properly placed chills may cause the feeding of the casting by the metal being

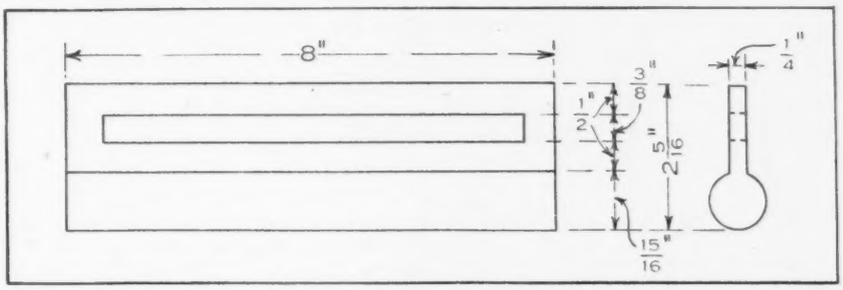


FIG. 3—SHRINKAGE TEST BAR

run in to proceed so far that the metal in the runner will complete the work after pouring ceases and make a perfectly sound casting. The gates and chills, of course, must be so arranged that the later-poured metal may flow in over that already in the mold; hence the neighborhood of the gate must not be chilled. It is also essential that the first metal be run in rapidly, and the pouring completed slowly.

In some cases the runner will feed such a casting even without the assistance of chills; in others, the chills are necessary to produce a sound casting; and in any case, the casting must be low compared to the runner, so that there is no considerable portion of it above the gate. In theory, at least, such a casting, in order to be made sound by the metal in the runner alone, should be provided with a gate from top to bottom on one side, so that the feeding of all levels of the casting is by metal running in from above. Actually, of course, the gate need not be quite the full height of the casting.

Even when a sink-head is used in addition to the chills, so that we do not depend upon the runner to feed the casting after pouring ceases, this action of the chills is valuable, since it effects the feeding of the lower portions of the casting by the metal being run in through the gate. To take advantage of it to the full, the sink-head should be poured separately and from the top. Otherwise, we shall fill the head with the first-poured metal that has been cooled by the chills, and the head will tend to cool before the casting.

We spoke above of the fact that a high casting, poured through a single gate at the bottom, may freeze at or near the top to such an extent as to bridge off the sink-head from the lower part of the casting with the result that

the piece will be unsound below. This, we saw, can be guarded against by the use of gates at several levels. The same end may be attained in certain cases by the use of chills on the lower parts of the casting, which so hasten the cooling of those portions as to cause them to freeze ahead of the upper parts. Manifestly, however, it will be advisable in many cases to use both these methods, since their effects are cumulative. Indeed, if the metal is all poured through a gate at the bottom, the effectiveness of the chills will inevitably be reduced by the chilling of the metal that first enters the mold and ultimately forms the top of the casting, which has to flow over the chills to a certain extent and consequently is not as hot as it should be when it reaches its final position. When, on the other hand, the metal enters at several levels successively the bottom of the casting is filled by the first metal entering the mold, and hot metal is run in on top of it through the upper gates; and in addition, the freezing of the lower portions is hastened by the chills. We thus get the full benefit of both the chills and the pouring in layers, so that as just stated their effects are cumulative.

Sizes of Gate and Runner

This brings us to the consideration of the proper relative proportion of the sizes of gate and runner. The latter should obviously be large enough to carry the metal into the mold as fast as it is needed; therefore, it must be able to carry away the proper sized stream of metal as fast as it is poured from the ladle. Now if this is the case, and the gate or gates are of smaller cross-section than the runner, the latter will fill up with metal rapidly. The difference in level between the metal in the casting and that in the runner will then increase putting more pressure upon the metal in the gate and increasing the velocity of its flow. This will be disadvantageous, first, because it will tend to cut out the sand of the mold, and second, because it will diminish the rate at which the casting as a whole is filled, and especially the rate at which the last metal enters the mold. For while the velocity of the entering stream will be increased as the runner fills up, so that at first the quantity of metal entering the mold will be maintained at nearly its proper amount; yet when the runner is full, the velocity cannot be further increased, and will as a matter of fact fall, as the casting fills and the difference in level between the metal in the casting and that in the runner decreases. As a result, the metal toward the last will enter the casting very slowly, and the gate and lower part of the runner may even freeze. We see, therefore, that the area of the gates should equal that of the runner.

Average Rate of Flow

To put this somewhat differently, and perhaps more exactly, the average rate of flow is determined by the size of the gate and the average difference of level between the metal in runner and casting during the pouring of the mold. If the gate is so much smaller than the runner that the latter is full practically from the time pouring begins, the flow at first will be proportional to the height of the runner, and at the last will be zero,—the average flow being proportional, then, to half the height of the runner. If the gate and the runner are of the same size and capable of carrying the metal as fast as it is run in, the difference in level between the metal in the casting and that in the gate will be practically uniform throughout; since this level will be that which suffices to overcome the friction of the flowing metal against the sides of casting, gate and runner. As the metal grows cold in the casting and its fluidity decreases, this friction will increase, so that the difference in level will gradually increase. Thus the flow will be fairly uniform throughout, and a considerable decrease in the rate of pouring toward the last will be voluntary (as by decreasing the rate of pouring), rather than involuntary.

Thus the cross-section of the gate or gates should be equal to that of the runner,—in most cases there will be no object in making it greater. Should there be a number of gates, however, whose total cross-section is equal to that of the runner, they may be individually so small as to be in danger of freezing. In this event, their total cross-section may be made greater than that of the runner.

In filling a high casting through a single gate at the bottom, the metal that first enters the mold often becomes cold and semi-solid and by its friction against the side of the mold greatly retards the rate at which the metal rises in the mold. The more slowly the mold is filled, the more pronounced this retardation. Hence, we must use a gate and runner of large cross-section; for if they are small the mold will be filled so slowly that the metal first poured will become very much chilled before it has reached its final resting place, this chilling will greatly decrease the rate at which the metal flows into the casting, and the small gate and runner will be very apt to freeze shut. Hence, a high mold requires larger gates and runners than a low mold of the same cross-section, resulting in a greater loss of metal scrapped as sprues per pound of casting.

From what has already been said it is apparent that in the designing and locating of sink-heads, it is important so to place the casting in the mold and so to distribute the chills that the maximum amount of feeding will be done (1) during pouring, by the hot metal being run into the mold; (2) by the heavy sections of the casting which feed the light sections placed below, and (3) by the heads during the time when they are actually being filled (preferably from the top, so that they will be poured with fresh hot metal). In many cases it is impossible to take advantage of all of these methods. By careful arrangement, however, it is generally possible to utilize one or more of them, so that the heads have the least possible amount of feeding to do after the pouring is stopped.

Thus in designing and placing heads we first consider how far we can take the work of feeding away from them and put it somewhere else. Then we consider the size of the head to be used, in view of the size of the section to be fed, and especially in view of the size of the neck through which the head is to feed.

Size of Head and Neck

In a great many cases, the thickness of the neck is fixed by that of the portion of the casting upon which the head is set. This being true, we are confronted with the law of fluid pressure. That law teaches us that if the diameter of the neck is small it is, from one point of view, quite useless to use a very wide head, because such a head exerts no more pressure upon the metal in the neck than would a head of equal height and of the same diameter as the neck. As far as exerting pressure upon the neck goes, only the height of the head is effective, and from this point of view the best head is one of diameter equal to that of the neck and of such a height that it shall contain enough metal to do all the feeding that will be needed.

But there is, of course, another side to this question, which is that a high and very narrow head would inevitably freeze to the center and cease to feed long before the cavity in the casting had been filled up, or to speak more accurately, before the cavity had ceased to form. We must, therefore, make the head of such a diameter that it shall not freeze to the center until after the necessity for its remaining molten ceases to exist,—in other words, the head must be at least as large, generally larger,

than the section of casting it is to feed. It is quite useless, however, to provide a head of just the right proportions, if the neck freezes before the head has ceased to feed. Hence, the diameter of the neck must be great enough to prevent its freezing prematurely. The rate of cooling of a neck of a given diameter, moreover, is greatly influenced by its length and by the shape of the head.

We see, therefore, that when the diameter of the neck is fixed, as for instance by the width of the portion of the casting to which it is attached, the neck should be made as short as possible, and the head should be made with a square bottom and no wider than will suffice to keep its interior liquid and maintain the feed up to the moment when the neck freezes. All extra width beyond that necessary to accomplish this is so much plain waste of metal. The height of the head also should not be greater, for a given diameter of head and neck, than is necessary to provide enough metal to feed the casting completely. The head that has done its work to perfection would be hollow just down to the neck. Frequently we see heads 8, 10 and even 12 inches in diameter and 18 inches or 2 feet high, with necks only 2 inches wide and 3 or 4 inches high. Manifestly, such heads have contained fluid metal and been capable of feeding the casting long after the neck, and even the casting itself, have solidified. The reservoir of liquid metal in the head is quite useless for the purpose for which it was provided, like a power dam with the flume to the turbine choked with mud, —the liquid we require to do our work is there, but it cannot flow to the place where we wish to use it.

Factors to be Considered

The factors governing the proper size of head and neck for a given casting vary to such an extent that it is practically impossible to do more than estimate roughly, by the light of previous experience, how large they should be made, and then allow an ample margin for safety. Having made a casting with a given size of head, it may prove unsound, that is, it may show a pipe under the neck when the head has been knocked, or cut, from the casting. In that case, the best means of remedying the trouble has to be considered. Again, the casting below the neck may be sound. Generally, it is assumed in that case that the proportioning of the head has been correct,—and so it has, as far as making a sound casting is concerned. Often, however, the margin of metal that has been provided is too great, so that the waste in sink-head scrap is excessive, and it will pay to consider how much the sink-head may be reduced in size without risk of making an unsound casting.

Making Necks in Cores

To make the necks small, in order that the heads may be knocked off by means of a sledge hammer or drop ball or burned off at the least expense, is dangerous practice because it may well lead to premature freezing of the neck. The result will be a pipe in the casting which will have to be plugged by means of the welder, the expense of the job often more than balancing the saving made in the cost of removing the head. Moreover, when the pipe is irregular and partly discontinuous the plugging often merely fills the top of the opening, like a cork in a bottle, and leaves the casting dangerously weak. Many a broken casting shows this defect in a striking manner. We may get our work accepted on a first order by indiscriminate plugging of holes, but if many of our castings break and show unsound places we will be pretty sure to find the customer has gone elsewhere for further orders.

By molding the neck in a special core it can be made very short, so that although considerably narrower in at least one dimension than the head, it will feed very efficiently. The core is so thin and the neck consequently so short, in this method of molding, that the mass of hot metal in head and casting quickly brings the core to a high temperature and thus keeps the neck fluid. The result is a very perfect feed with a neck comparatively narrow in one dimension. Moreover, by properly shaping the opening in the core the neck may be so formed that it can safely be broken from the casting, even though quite heavy. Care has to be exercised, however, not to knock off too heavy a neck or one that is not shaped just right (caused in some cases by the partial disintegration of the core), as the heavy shock of the blow brought upon a casting already full of shrinkage stresses may crack the casting. This question is considered in more detail in the discussion of "hot" and "cold" cracks in castings.

It is plain that as the metal in a head flows, or tends to flow, by gravity, the action of the head is most efficient downward. The extent to which a head will feed an opening that extends chiefly in a horizontal direction is evidently not great. Hence, when a considerable extent of horizontal surface is to be provided with heads, especially if the vertical dimensions of the castings are small, a number of heads must be used and they must be placed so close together that their effects overlap. Such a casting will be more efficiently fed by a number of comparatively small heads placed close together than by a few heavy heads. At times such castings are provided with a few very thick, but comparatively short, heads, evidently with the idea that by providing great total weight of metal in the heads the casting can be fed throughout. Of course only the height of the heads is useful in providing the pressure required to force the metal to flow sidewise to the distant portions of an opening, so that the total weight of the heads has nothing to do with their effectiveness in feeding far in a horizontal direction. Short, thick heads, therefore, will feed only a limited area near their bases, frequently an area that cannot use all the metal they contain. Hence much of their extra weight is plain loss. Were this extra metal distributed over the casting in a number of small heads, on the other hand, it would nearly all be utilized in feeding the shrinkage immediately below each head.

In case only a few heads can be molded upon a casting of this sort, so that each head must feed horizontally to a considerable distance, we should remember that the amount of metal to be fed may not be great, but the pressure required to force it to flow sidewise through an irregular opening may be considerable. In order to produce this pressure we need high heads. Increased height of heads to feed such a casting should in some cases be accompanied by decreased diameter, in order that there may not be too much waste of metal.

Use of Heavy Heads

Another error sometimes committed is to use heavy heads with thick necks, attached to the sides of castings near the bottom. The heads are made very heavy, evidently with the idea that their total weight can be utilized in forcing the metal they contain up into the casting to feed the shrinkage of the latter. If they fail to feed as expected, heavier, but seldom higher ones, are tried.

Of course, when our laws of fluid pressure are again applied, the effective pressure exerted upon the neck of the casting shown in Fig. 1 by the metal in the heads, is proportional only to the difference in level A-B between the metal in the head and that in the casting, so that after pouring is stopped only the portion A-B of the head is effective in producing pressure on the metal in the neck to make the latter flow. Increased diameter of head will not increase this pressure in the slightest—though by keeping the metal hot longer, it prolongs the period

during which the pressure is exerted. Increased height of head, on the other hand, greatly increases the pressure.

Moreover, the heads, so attached, are laboring under the disadvantage that they do not feed their fluid metal directly downward into the top of the gradually deepening pipe, but have to do their work by bringing pressure to bear on the still liquid metal in the casting, by which that metal is made to flow upward and close the pipe, as it does when a solidifying ingot is compressed at the bottom. Working in this manner, the heads must fail to be effective as soon as the metal in the casting becomes too sticky to flow; and they cannot, however long they stay fluid, feed the portion of the pipe that forms after the metal of the casting has become solid. A head placed on top of the casting, on the other hand, continues to feed the pipe so long as the head and neck remain fluid, and it feeds chiefly by direct flow, not by forcing the metal in the casting to move upward. Hence, it feeds efficiently at all stages of the formation of the pipe. Heads placed in the manner shown in Fig. 1 must inevitably be seriously inefficient, and in a great many cases might as well be omitted altogether as so attached.

Tipping Up Shallow Castings

Thin castings, especially long, narrow, shallow sections, are frequently tipped up at the gate end for pouring. The most obvious reason for doing this is that it assists the pouring by making the metal run down-hill, instead of along on the level, and so enables us to "run" a piece that we might not be able to fill in any other way. A further advantage of this method, however, is that it to some extent substitutes top pouring, and downward feeding by the heads along the length of the casting, for bottom pouring. The more we tip the casting up, the greater this advantage—indeed, whenever possible, we pour the thing "on end," so that when it is filled each section may feed that immediately below it, and a comparatively light head on top will suffice to give us a sound casting; while if we poured "on the flat," we might need several heads distributed along the casting.

In some cases such a casting can be made sound by the action of chills placed upon the lower end, without the use of sink heads. The metal running in through the gate does much of the feeding while the casting is being poured, and the metal in the runner suffices to feed the final shrinkage that takes place after pouring ceases. In case the effect of the chills will not suffice to make the casting sound, heads are necessary. These are frequently placed toward the lower end of the casting, especially if that end is the heavier. So located, the heads are not in a position to feed as efficiently as they should. In Fig. 2, for instance, we see that if the runner will suffice to feed the casting as far along as *A*, then the rest of the metal in the casting, from *A* to *D*, will tend to run downward toward *D*, and will exert a fluid pressure proportional to *A-E*, the difference in level between *A* and *D*. The portion of the head *B-D*, equal to *A-E*, is useful only to balance this pressure, and only the portion of the head *B-C* exerts pressure upon the metal in the casting. Moreover, the conditions are much like those in the case of the side-attached head already discussed—we are trying to make the head close a pipe which will form in the upper portion of the casting, between *A* and *D*, by forcing the metal below to flow back against gravity and close a distant opening. A second head between *D* and *A* might or might not be so located as to be just over the place where the pipe tends to form, since the position of this pipe will vary from casting to casting, depending upon the temperature of the metal when poured, how fast it is poured, etc.

If for any reason it is essential to place the head on such a casting at the lower end, the head should be made as high as possible and should be poured separately with hot metal from a second ladle. If the head is filled with the metal run in through the gate, the metal in the head will be cold when pouring ceases, more especially if chills are used on the heavy portion to counteract to some extent the tendency to freeze at the top first; and as we have seen, the heads should, whenever possible, be filled with hot metal. If there is nothing to prevent it, the casting should be tipped up and gated at the heavy end, in order to conform to the rule that the top should be the last portion to freeze and the head should be on the upper end, for the same reason. Chills, if used at all, should be on the lower end, but if the lower end is much the lighter they may not be needed.

Cracks in Castings

Cracks in castings are due primarily to the shrinkage of the steel in cooling from the temperature of solidification to that of their surroundings. The shrinkage of ordinary carbon steel amounts to about ¼-inch per foot, being somewhat less as the carbon approaches 0.90 per cent, and greater the lower the carbon. Could all parts of the casting cool at the same rate, shrinkage would not make trouble. But when a light portion cools ahead of a heavy one, the resultant shrinkage of the light section often brings a heavy pull on the heavy one when the latter is still hot and weak, resulting in the tearing apart of the two at the weakest place—which is not necessarily the smallest section, but that which is weakest at the temperature existing when the stress is set up. Should the casting hold together, the later shrinkage of the heavy portion after the light part has become cold and rigid often sets up heavy compression stresses in the latter. Thus in the shrinkage stress test bar shown in Fig. 3, the light section cools first, the hotter heavy part yielding to the pressure. Then when the heavy portion begins to cool faster than the light part, the latter is compressed very strongly, so much so that if it is cut in two with a hack saw when cold, the moving together of the sides of the cut can be measured very easily. The magnitude of the stress set up is very great;—so great that a blow with a hand hammer on the heavy part, and not a very heavy blow at that, suffices to snap the connecting leg between the light and heavy portions as if it were a pipe stem.

Cracks are favored by: High sulphur in the steel, causing red-shortness; low carbon, which gives the maximum shrinkage; unevenness of sections, causing variations in the rate of cooling; sharp corners in angles of castings, especially where a thick section joins a thin one; use of tie-bars stronger than the casting; and resistance of mold and cores to shrinkage of casting.

Effect of Sulphur

We are obliged to make our castings either of a definitely specified carbon content, or of a low enough content to make the castings tough when annealed, and easily machined. We cannot, therefore, alter the carbon content to decrease the shrinkage. The sulphur content depends upon the raw material and the steel making process we use. Basic open-hearth steel can be kept quite low in sulphur, basic electric furnace steel even more so, without very great expense. Acid open-hearth, Bessemer and acid electric furnace steel frequently run rather high in sulphur, so that the foundryman who uses them is obliged to exercise more care in guarding against cracks than the user of basic steel. The effect of high sulphur content is to make the steel weak and brittle when hot (red-short), so that it more readily tears apart under shrinkage stresses.

Tie-bars are extra pieces of metal used to bridge across from one part of a casting to another, and serve to prevent the shrinkage from warping the casting out of shape. When they are made too strong they may serve their true purpose so well as to overdo it. For if the shrinkage stresses which they resist should become so great that something must go, obviously the weakest part will be the victim. Hence, the tie-bar often has to be so designed that it will be sure to fail before the other portions of the casting; and in some cases it is notched

to insure that it and not the casting itself shall give way under the stress, should the latter be great enough to break something.

Many castings are so shaped that the resistance of cores or portions of the mold to the shrinkage of the steel will result in the cracking of the work unless the sand is thoroughly loosened up as soon as the steel is solid. The fillets and brackets, chills, etc., may prevent cracking at the time of solidification, but further cooling with the shrinkage that accompanies it will crack the casting unless the enclosed sand is so loosened that it does not oppose shrinkage. This can be taken care of to a certain extent by making cores in such a manner that they will crush easily when the shrinkage of the steel brings pressure to bear upon them, and (especially in the case of green sand molds) by not ramming the sand too tight, so that it will yield to the pressure of the contracting casting. But many cores, or portions of the mold proper, which are so located that they will seriously oppose the shrinkage of the casting must be broken up with bars soon after the metal solidifies. Frequently also, the resistance of the sand in the cope to the motion of the sink-heads as the casting cools will have the same effect unless the cope is broken up.

Another result of this resistance of the mold to the shrinkage of the steel is to alter the dimensions of the piece to an extent depending upon the total shrinkage and the degree to which it is prevented by the sand. Thus very long castings with many heads will vary somewhat noticeably in length depending upon whether or not the mold is thoroughly loosened up. The reason for this is, of course, that if the shrinkage of the casting is opposed to a sufficient extent to overcome its elastic limit at the temperature existing at the time, the steel yields to the stress and assumes a dimension not proper to it at that temperature. On further cooling, the casting does not shrink to the dimensions it would have attained had its shrinkage at higher temperatures been unopposed. This virtual expansion, which is analagous to that of the outside layers of an ingot which gives rise to pipes, is often sufficient in amount to make a serious difference in the dimensions of long castings.

Cooling the Castings

When the sand of the mold and core has been loosened up the casting may be cooled in several different ways, depending upon the total shrinkage of the steel, its brittleness when cold, and the extent to which the sections vary in size. If the danger of setting up severe shrinkage stresses is not too great the castings may be allowed to cool off in air. Should there be danger that the stresses set up by this rapid cooling will break the castings, they may be buried in loose sand or ashes and allowed to cool more slowly. Very complicated pieces with widely varying sections, especially of rather brittle steels, cannot be cooled even in sand without danger of cracking, and must be placed hot in a furnace or pit, generally preheated to about the temperature of the castings, and allowed to cool off slowly and uniformly. Even castings of ordinary 0.25 per cent carbon steel sometimes break in two when quite cold, with a noise like a great gun, from the stresses set up by too rapid cooling.

It is apparent that a cold casting already so full of shrinkage stresses as to be in some danger of breaking, will almost surely crack if these stresses are increased by rough handling. It is advisable in most cases to remove heads and gates before annealing the casting, but we should be careful how we do it. The practice of pounding off heads and gates with a heavy sledge hammer, dolly or drop ball is one to be avoided whenever possible. The stress produced by the heavy blow, added to the shrinkage stresses in the casting, may break or crack the piece. If the casting is of brittle steel, the head breaks off quite easily—but on the other hand the casting itself will break quite easily under a comparatively slight extra stress, especially one applied suddenly. If the steel is tougher, there is less danger of cracking the casting with a blow of given intensity—but the head will be harder to break off, so that the blow must be more severe. Before making a practice of breaking off the heads of castings from a given pattern, it is advisable to be quite sure that there are no cracks, visible or concealed, produced in the process—and then to allow a liberal margin for unforseen contingencies, and cut or burn off all heads that require more than a comparatively slight blow.

Determining Carbon in Cast Steel Rapidly

By Walter L Morrison

WHEN an electric furnace is used in the foundry to make steel according to certain specifications, a rapid and efficient method for the determination of the carbon content is necessary. Color carbon works out very well until alloy steels are dealt with, then it is unreliable. The writer, after trying various methods given in the literature as rapid and reliable, could find none sufficiently well suited for the work at hand. The direct combustion method was finally adopted. The ordinary apparatus was simplified to a point consistent with reliability, and a few new features were added. The result was that a carbon determination could be made in from four to six minutes, with perfect accuracy, that is, to check within two points of carbon using a half factor weight. The apparatus, as shown in Fig. 1, consists of a complete combustion train with a balance for weighing the absorbing gas. The carbon in the steel is burned with oxygen, as in the ordinary combustion furnace. The carbon dioxide passes from the quartz tube through a ⅜-inch glass tube, one-half of which is

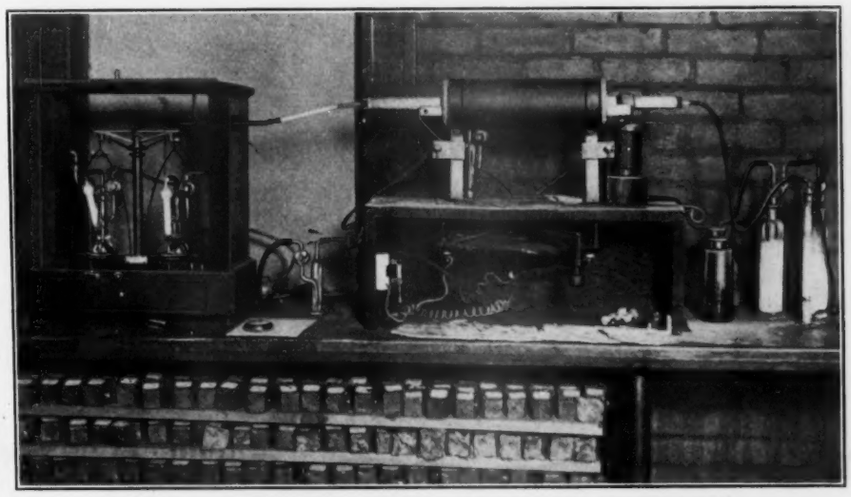


FIG. 1—COMBUSTION TRAIN CONNECTED TO BALANCE

filled with zinc sponge and the other with dry calcium chloride. A cotton plug is used in either end. The carbon dioxide is absorbed in a Johnson's bulb resting on one of the balance pans, a similar bulb being used as a counterpoise. In this work a cheap balance is better than a more expensive one. An Eimer & Amend balance was used.

The edge on the beam supporting the pan should not be lifted. The agate plane which rests on the agate knife edge, should be so constructed that it will not turn with the slight torsion caused by the rubber tube connected to the absorption bulb. This is accomplished by the use of a cheaper grade of balance, as stated.

A hole is made in the side of the balance case, as near the back as possible, a glass tube of sufficient length to allow rubber connections on both ends is inserted and fastened, either with a little water glass or glue. The outer end of the tube is connected to the combustion apparatus by rubber connection. A ⅛-inch black, light wall, rubber tube is connected to the glass tube inside the balance case, the other end of the rubber tube being connected to the absorption bulb on the left pan of the balance. A slight drooping of the tube should be allowed, to decrease the friction when weighing. It is important that a pliable rubber tube be used, otherwise the friction is increased and the sensitiveness of the balance decreased. A counterpoise bulb is placed on the right pan of the balance. In weighing the absorbed gas, it is much easier to weigh to a standstill on a very slight swing.

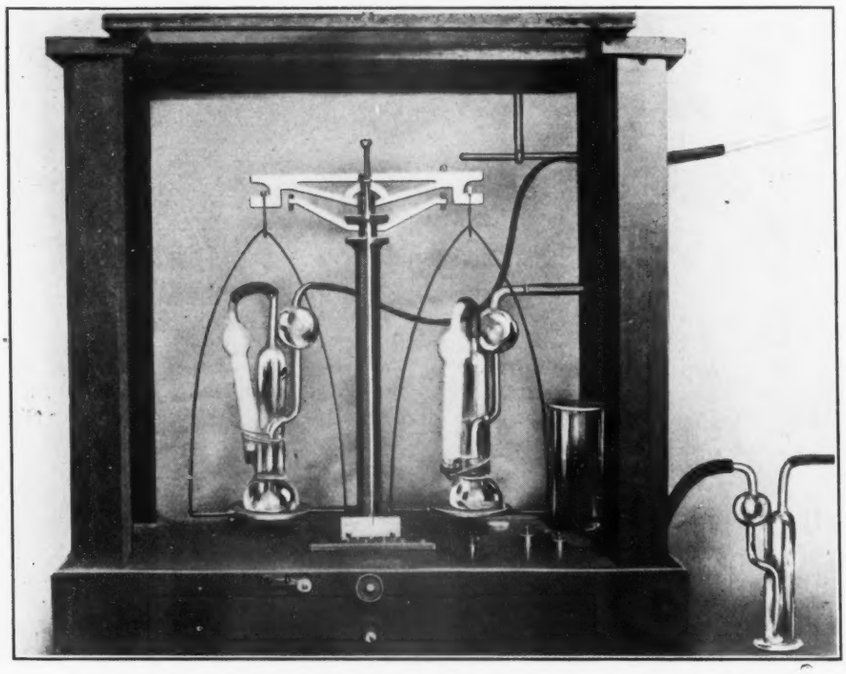


FIG. 2—DETAILS OF ABSORPTION BULB IN THE BALANCE CASE

Operating the Train

In the operation of the train, the furnace is run at a temperature of 940 to 1,000 degrees Cent. A half factor weight of drillings is used. The drillings are placed in an alundum boat containing 90 mesh alundum sand. After thoroughly blanking the bulb by continued aspiration with oxygen, the light weight is taken with the train aspirating at the usual rate, which is about the same when the final weight is taken. After taking the light weight, the drillings are introduced in the furnace and the current of oxygen cut down to a few bubbles. As soon as the steel begins to burn, the supply of oxygen is gradually increased, giving the train all it will take without causing an excess bulbing in the absorption bulb. The burning of the steel usually requires from one to two minutes, depending on the carbon content. As soon as the burning is finished, the supply of oxygen is cut down to a normal rate. A faster rate of aspirating than that used on the regular combustion trains can be employed without loss. About 1½ to 2 minutes is required for the absorption of the carbon dioxide gas in the caustic solution. The determination of carbon in steel by this rapid method can be made in four to six minutes, depending on the carbon content. The best time that can be made with color carbon is six to ten minutes. With color carbon determinations the personal equation enters into the determination, while with the above method this is not the case.

There is no noticeable vibration of the balance due to the bulbing of the gas in the absorption bulb, as might be expected. Using an absorption bulb as counterpoise, eliminates, to a certain extent, any error due to change in temperature or the presence of oxygen in the balance case. The oxygen valve is placed at the end of the box, next to the balance, in order that the operator may control the supply of oxygen as he sits before the balance.

This method is believed to be more rapid than any method heretofore used and is accurate. This rapid combustion train is used for the determination of carbon in the preliminary tests from the electric furnace. Three different men operate the train during the 24-hour day, in conjunction with their other work, and it is surprising how close the results check with those obtained on the regular train. The average error varies during the course of the week from one to two points of carbon. With the rapid combustion train an operator can get out at least 80 combustions in eight hours. There are no absorption bulbs to handle. The final weight is taken as soon as the carbon dioxide gas is absorbed, which means a saving of at least two minutes on each determination. I find the balance as used is sensitive to an amount equivalent to ½ point of carbon. This apparatus has now been used over two years.

An interesting pamphlet devoted to the handling of materials by grab buckets of various types has been issued by The Hayward Co., 50 Church street, New York. It contains a large number of illustrations showing installations of the Hayward equipment, handling coal, sand, rock, etc. The illustrations are accompanied by explanatory text matter.

The Basic Mineral Co., N. S., Pittsburgh, is forwarding to the trade a sheet of instructions for the use of Miller flux in melting gray iron in the cupola. This circular contains many suggestions which will prove of value to cupola operators.

A six-page folder issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is devoted to single-phase motors in capacities from ½ to 1½ horsepower.

THE BRASS FOUNDRY

Tests of Natural Gas-Fired Brass Furnaces

By Fred L Wolf and Robert B Burr

THE purpose of this paper is to summarize briefly the results obtained from a series of tests made under shop operating conditions, on various types of available brass melting furnaces, at the plant of the Ohio Brass Co., Mansfield, O., using natural gas as a fuel. The object of these tests was to endeavor to increase the efficiency of the furnace by making use of the present equipment without entering into too great an expense for alterations.

The gas was obtained from the medium pressure mains and was conducted to the furnace through regulating valves, the volume having been measured by a Toby meter. The air necessary for combustion was obtained from an independent blower outfit, the volume being measured by a Westinghouse proportional meter. This independent blower was installed so that any air pressure up to 32 ounces could be obtained at will, as the highest available pressure, under factory conditions when all equipment was in use, was approximately, 14 ounces. The results of our tests showed that by a proper burner construction and manipulation, as efficient results could be obtained with 4 ounces of gas and 14 ounces of air, as with higher pressures, and with, of course, a consequent reduction in the cost of compressing the air. The gas and air meters were checked at intervals of four or five days and were found accurate within one per cent.

In these tests the same class of metal, consisting of brass ingots, weighing approximately, twenty pounds each, analyzing 85 per cent copper, 8 per cent zinc, 4 per cent lead and 3 per cent tin, melted and poured into the same class of castings at the same temperature. The furnace was operated throughout these tests by the same men under the direction of the authors.

The furnaces tested consisted of the following types:

First. — Pre-heated air, non-tilting, chamber type of burner, illustrated in Fig. 4, crucible furnace, designed for use with No. 60 pot. The general design of this furnace is indicated in Fig. 1.

Second.—Non-tilting, pre-heated air type, crucible furnace, in which the crucible is handled with a split shank, by elevating the furnace body by means of a rack and pinion. The construction is shown in Fig. 2.

Third.—Converted coke furnace of non-tilting pit type, shown in Fig. 3.

Fourth.—Open flame furnace, capacity approximately 800 to 900 pounds per heat.

While the prime object of these tests

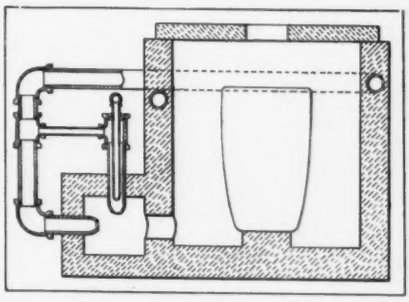


FIG. 1—CROSS-SECTION OF A NON-TILTING CRUCIBLE FURNACE DESIGNED FOR A NO. 60 POT

was to increase the efficiency of the furnace and lower, if possible, the gas consumption, due regard was paid to the chemical composition of the furnace atmosphere to conserve the quality of the metal and prevent undue oxidation or scumming.

Frequent analyses were made of the furnace atmosphere by the Williams' type of Orsat apparatus, and our experience shows that with a neutral furnace atmosphere, or one containing a slight excess of carbon monoxide, not more than one per cent being found necessary, no oxidation of the molten metal occurred, and this without the necessity of covering the metal with charcoal, coke, or glass, or other agents to prevent oxidation, the melted metal retaining its mirror-like surface.

It is true, of course, that the slight carbon monoxide content reduces the efficiency of the furnace as regards consumption of fuel, but this reduced efficiency is more than offset by the decreased shrinkage and superior quality of the metal.

Data sheet 1 shows the result of tests on the furnace illustrated in Fig. 1. Column 1 shows the data obtained on the trial tests before purchasing. It will be noted that in this column the gas consumption per 100 pounds of metal melted, corrected to 4 ounces pressure and 60 degrees Fahr. basis, is 351 cubic feet. As no records of air temperature and volume were kept, the ratio of gas to air is not given.

Column 2, *Data sheet* 1, gives the data for the same type of furnace after two years operation. It will be noted that the gas consumption is the same, and the ratio of gas to air is 1:8.12. It will also be noted that 200 degrees of pre-heat was obtained, by circulating the air through pre-heating coils shown in Fig. 1.

Column 3, *Data sheet* 1, gives results obtained by using a pressure of 4 ounces of gas, 10 ounces of air, in the same furnace. It will be noted that the gas consumption is in considerable excess of the preceding test, consuming 451 cubic feet per 100 pounds of metal melted. The ratio of gas to air has fallen at these pressures to 1:7.4 due to the burner construction and insufficient air pressure.

Column 4, *Data sheet* 1, gives the results obtained by using a gas pressure of 4 ounces, and 14 ounces of air pressure. It will be noted that the gas consumption per 100 pounds of metal melted, is 390 cubic feet, at a ratio of 1:9.07. The ratio of gas to air is a more efficient ratio than that shown in column 2. However, owing to reduced air pressure an inefficient mixture was obtained with this type of burner.

The increased gas consumption is without doubt, due to an inefficient mixture, or one in which stratification of gas and air currents are taking place.

We found that using natural gas of approximately 1,000 British thermal units per cubic foot, with gas corrected to

Presented at the Chicago, 1914, meeting of the American Institute of Metals.

4 ounces pressure, 60 degrees Fahr. we obtained a maximum efficiency of 351 cubic feet per 100 pounds of metal melted, with a pre-heat of 200 degrees Fahr., and a gas and air pressure of 25 ounces. We found that the results obtained on the preliminary tests before

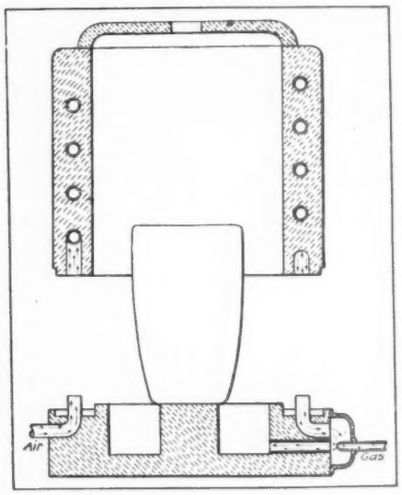


FIG. 2—CROSS-SECTION OF A NON-TILTING, PREHEATED AIR TYPE CRUCIBLE FURNACE

purchasing, can be maintained under shop operating conditions, provided sufficient air and gas pressure are available.

This type of furnace and equipment is open to the following objections: The burner is so constructed that it does not produce an efficient mixture of gas and air, unless relatively high pressures are used; the arrangement is such that part of the combustion takes place in the combustion chamber, the walls of which are thin, producing a relatively large loss to the surrounding atmosphere by conduction and radiation.

The burned chamber is separated from the crucible chamber by a heavy lining which is pierced by a passage approximately 3 inches in diameter. This lining obviously, prevents the radiant heat from the walls of the combustion chamber heating the crucible. Due to the fact that part of the combustion takes place within the chamber, the heat generated causes this to become distorted, giving rise to a considerable loss of gas through leakage and increasing the repair item. The continual leakage of the gas makes it injurious to the furnace tender.

Results of Tests

Data sheet 2 shows results of tests run on the furnace illustrated in Fig. 2. Column 1, *Data sheet* 2, shows the data obtained by operating this furnace with the pre-heated air coil. It will be noted that to obtain efficient results, the air pressure must be maintained at 32 ounces. The gas consumption corrected to 4 ounces pressure, 60 degrees Fahr. per 100 pounds of metal melted, averaged 258.4 cubic feet, while the air corrected to the same temperature and pressure, showed a consumption of 1988.8 cubis feet, which gives a ratio of 1 : 7.68.

Referring to column 2, it will be noted that this furnace was operated with the pre-heating coils cut out. The gas consumption was increased to 321.23 cubic feet, or an increase of 19.7 per cent to 100 pounds of metal melted, with a ratio of 1:8.82. It will be further noted from a theoretical standpoint this ratio of 1:8.82 is more efficient than with the pre-heating coils, which was 1:7.68.

There unquestionably is a considerable increase in the efficiency due to preheating the air. It should be stated that owing to the type of burner employed, Fig. 2, it is not fair to credit the preheating of the air with 19.7 per cent increase, for the reason that owing to the type of burner with pre-heated air cut out, not so efficient a mixture of gas and air was obtained.

This furnace, from a mechanical standpoint, does not seem to be practical, the life of the lining, owing to the construction, particularly of the body of the furnace, would apparently be short. The furnace is inconvenient and the men complain of the heat radiated from the base of the furnace when the body is lifted. Unless considerable care is used in properly sanding the base block, tendency was encountered, for the body of the furnace to become fused to the base. A great deal of care must be exercised in raising the body of the furnace, due to the fact that with the small base block employed, considerable danger of the crucible falling out of the furnace was encountered, making it necessary for the men to place the split shank in position as soon as the body of the furnace was lifted high enough to permit them to do so, it being found necessary for them to steady the crucible in this position until the body of the furnace was completely elevated. The cost of repairs on this furnace would no doubt be excessive in comparison with the cost of other furnaces.

Considerable difficulty was experienced by the furnace tenders in properly inspecting the condition of the metal during the melting and also in adding the mix, owing to the fact that the hole in the cover was elevated above the floor line, approximately 4½ feet, bringing the metal closely on a level with the furnace tender's face which objection holds true of any elevated type of furnace, unless a platform is used. While the efficiency of this furnace is relatively high, its mechanical objections are many.

Data sheet 3 gives results of furnace tests upon a non-tilting pit type of converted coke furnace, equipped with a gas burner illustrated at *A*, Fig. 5.

Column 1, shows data obtained with a 1¼-inch tube type of burner with twenty-four 3/32-inch holes in the gas tube. While the gas consumption was comparatively low, still the time required per heat was equal to 58 minutes. Referring to column 2, the burner was enlarged in this case to a 1½-inch tube with forty-eight 3/32-inch holes. It will be noted that the gas consumption per 100 pounds of metal melted is equal to 344 cubic feet, this is 13.37 per cent higher than the results shown in column 1. Upon investigation, it was found that the burner entered the furnace at right angles, so that the flame impinged on the base block.

Position of Burner

Referring to column 3, the same burner was used, the only difference being that the burner entered the furnace at a tangent and was so inclined as to produce a forward and whirling motion, without impinging on the base block.

The gas consumed is equal to 297 cubic feet, which is practically the same result as that shown in column 1, while the time element was reduced eight minutes, the ratio of gas to air being 1:7.69.

This consumption of 297 cubic feet is an increase in efficiency of 23.82 per cent over the burner and furnace shown in Fig. 1, employing a pre-heating coil, and operated with the same pressure, illustrating the fact that it is possible to construct, out of pipe and fittings, an efficient and economical burner which permits the use of low gas and air pres-

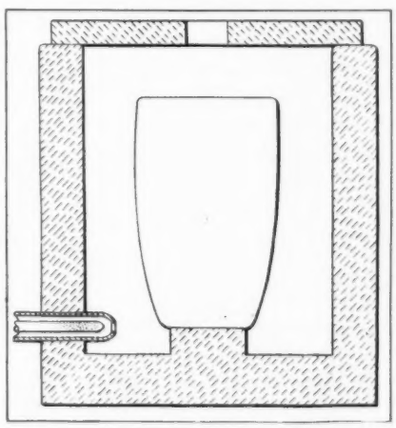


FIG. 3—CONVERTED COKE FURNACE OF THE NON-TILTING PIT TYPE

sure, and which avoids the complication of renewing burner nozzles.

Column 4, *Data sheet* 3, gives results of 13 heats obtained by operating the non-tilting type of pit furnace, after same had been equipped with approxi-

mately, 30 feet of 2-inch pre-heating coil. This coil consisted of 18-inch lengths of 2-inch pipe fitted with the necessary ells and tees, and placed vertically, just inside the shell of the furnace, between it and the firebrick lining. These pipes were so arranged as to form a multiple path for the air, and contrary to our expectations, the numerous ells did not raise the air pressure necessary, due to the multiple path provided. With this arrangement the same type of burner was used as in tests tabulated in column 3, *Data sheet* 3.

Use of Pre-Heated Air

The pre-heating coils produced a rise in temperature of 347 degrees in the air used for combustions and the time of the melt was reduced to 46 minutes, a shrinkage loss of 1.16 per cent. The ratio of gas to air, corrected values, was 1:8.55.

The apparent increased efficiency, due to pre-heating the air, was 14.8 per cent. It will be noted that the ratio of gas to air with pre-heating coil is 1:8.55, as against 1:7.69 without pre-heating coil, and this higher ratio of air to gas approaches more nearly the amount necessary for perfect combustion; it is, therefore, not fair to credit the entire saving of 14.8 per cent to the pre-heating of the air. This change in the ratio of gas to air illustrates the difficulty, under factory operation of maintaining a uniform ratio of gas to air, and accounts for the inconsistencies between special tests and shop operation. Considerable difficulty was experienced due to fluctuating gas and air pressure, which lead to an investigation of the possibility of an automatic regulation of

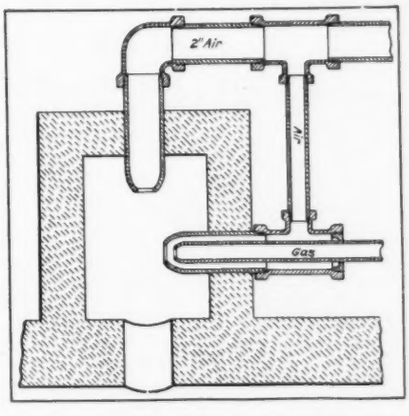


FIG. 4—CROSS-SECTION OF TYPE OF BURNER WITH WHICH FURNACE, FIG. 1, WAS EQUIPPED

the gas and air pressure, to the end that a uniform ratio of gas and air might at all times be maintained in the burner.

Such apparatus has been designed and constructed, and the preliminary tests prove satisfactory, it being possible to regulate the gas and air pressure to less than 0.1 of an ounce, and maintain automatically, any desired ratio between the gas and air pressure. However, sufficient data are not available at the present time to more fully describe this arrangement. It is, however, obvious that any method or system of burning with gas or oil, to produce uniform and consistent results, must be made in a large degree, automatic, and as near foolproof as possible to produce maximum efficiency. Various factors must be considered, the quality of the metal, the shrinkage loss, the proper furnace atmosphere, and the proper ratio of gas to air to produce same. To maintain this efficiency the furnace equipment should be so designed that the furnace operators cannot vary the pre-determined ratio.

An attempt to increase the efficiency of mixing the gas and air, was made by constructing a burner as illustrated at *B*, Fig. 5. This burner was tested, but the results indicated that the tube type of burner, shown at *A*, produced as efficient a mechanical mixture of gas and air as the more complicated baffle burners illustrated, and without reduced velocity of the gas and air in the burner. In other words, the mechanical mixture produced by the tube type of burner seems to be as efficient as any of the more complicated methods described.

The tube type of burner used on the pit furnace is shown at *A*, Fig. 5. This burner was a considerable improvement over the chamber type, gas analyses showing practically a complete mechanical mixture of gas and air, which of course, is the prime object of any type of burner. The mixture is produced without appreciable loss of velocity and with relatively low pressures of gas and air, resulting in a consequent reduction in the power cost of air. On account of the ejector effect of the air on the gas tubes, temporary low gas pressure, while of course reducing the total amount of gas available, does not cripple the operation of the plant, making it possible for the foundry to remain in operation even if the pressure be reduced several ounces.

The burner may be constructed by the shop repair man, with the necessary pipe and fittings, which are always available, and its construction requires no machined parts, or complicated castings. The installation requires no complicated pipe fitting and the maintenance is practically nil. The burner will not burn out, due to the fact, that it is not exposed to the temperature of the furnace, and is kept cool by the gas and air mixture. With this type of burner no leakage of gas, air, or the mixture ensues, due to the absence of any warping effect.

From the results of this investigation, it is apparent that the typical pit type of coke furnace, may be equipped at very slight cost, for the use of natural gas with resulting economy in the consumption of gas equal to any specially-built natural gas furnace which has the same depth of lining, and which does

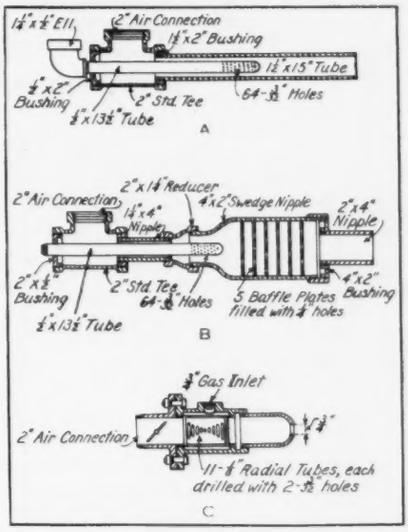


FIG. 5—CROSS-SECTIONS OF VARIOUS TYPES OF BURNERS USED

not employ a method of utilizing the heat of the waste gases. Substantially the whole cost of such an equipment is the necessary blower, and pipe, and fittings, and labor.

The pit type of coke furnace has many advantages in saving of floor space and floor obstruction; it places the molten metal a considerable distance from the face or person of the melter; it is convenient for charging, and we can see no logical reason for discarding any pit type of coke furnace, the drums of which are in good repair, when changing to the use of natural gas.

Advantages of Coils

Reference to the preceding data will show a considerable increase in the efficiency of the various types of furnaces tested, due to the use of coils in the furnace lining, which pre-heat the air used for combustion, and while these coils cannot be classed as devices for utilizing the waste heat of the products of the combustion, nevertheless, they tend to reduce the temperature of the outside of the furnace drums, and recover in a measure, considerable heat that would otherwise be lost through radiation. As previously stated, no serious difficulty was encountered in constructing these coils from pipe and fittings, nor was any difficulty experienced in their installation when converting the pit type of coke furnace to the use of natural gas. To date there has been no evidence of deterioration, after a period of several months use, and we can see no logical reason why their life should

not cover or equal the life of the furnace drums. It is quite evident, from our experience, that the economy resulting from their use more than justifies their installation.

Data sheet 4 gives result obtained by operating a No. 2 open flame furnace with gas as fuel. Owing to the fact that time did not permit, we were unable to obtain the shrinkage loss. It will be noted that the gas consumption per 100 pounds of metal melted, was equal to 199 cubic feet, corrected to 4 ounces pressure and 60 degrees Fahr. The class of metal melted consisted of equal parts of borings and brass ingots, which accounts for the fact that the gas consumption is somewhat greater than if brass ingots alone had been melted. The ratio of gas to air was found to be 1:10.68, which is in excess of the theoretical ratio. No doubt the furnace atmosphere was an oxidizing one. No efforts were made at this time to obtain an analysis of the waste gases, and the furnace operation was left to the furnace tender, who judged the heat by the color of the flame issuing from the spout of the furnace.

As the cost of the crucibles is a considerable item in the melting cost of brass, any statement of fuel cost per 100 pounds of metal melted in a crucible type of furnace, should include the crucible cost. The following crucible cost comparisons may therefore be of interest:

The actual average life of 140 No. 60 crucibles was 50.87 melts per crucible,

Data Sheet No. 1

	1 Trial tests before purchasing.	2 Chamber burner under factory conditions.	3 Chamber burner gas 4 oz., air 10 oz.	4 Chamber burner gas 4 oz., air 14 oz.
No. of melts	56	11	12	11
Metal weight in, lbs.	8,469	1,688	1,875.5	1,695.5
Metal weight out, lbs.	8,341	1,668	1,852	1,676
Loss in lbs.	128	20	23.5	19.5
Loss in per cent.	1.51	1.18	1.25	1.15
Min. required for melt.	49.4	45	53	45
Cu. ft. of gas used.	29,000	5,800	9,027	7,055
Deg. Fahr., gas temp.	91	91	91	91
Gas press. in oz.	25	25	4	4
Metered gas per 100 lb. metal	343	343	481	416
Cu. ft. gas corrected to 4 oz. press., 60 deg., per 100 lbs. metal.	351	351	451	390
Cu. ft. air metered.	...	50,800	66,901	62,891
Air temp., deg. Fahr.	...	103	103	103
Deg. Fahr., air temp. before entering preheating coil 86	103	103	103	103
Deg. Fahr., air temp. after leaving pre-heating coil	276	303	303	303
Deg. Fahr. pre-heat.	190	200	200	200
Air pressure in ounces.	26	25	10	14
Air metered per 100 lbs. metal	...	3,009	3,567	3,716
Air corrected to 4 oz. and 60 deg.	...	2,852	3,338	3,535
Ratio of gas to air, corrected values	...	1:8.12	1:7.4	1:9.07
Per cent of cop. in br's	79–80	79–80	79–80	79–80
Deg. Fahr. at which brass was poured.	2100	2100–2200	2100–2200	2100–2200
Class of metal melted.	Ingot	Ingot	Ingot	Ingot
Size of casting.	Valve	Valve	Valve	Valve
Kind of meter used, gas.	Toby No. 4 in all cases			
Kind of meter used, air.	Westinghouse proportional in all cases			

Data Sheet No. 2

	1 With pre-heated air.	2 Without pre-heated air.
No. of melts	10	10
Metal weighed in, pounds	1,469.5	1,471.5
Metal weighed out, pounds	1,453.0	1,453.5
Loss in pounds	16.5	18
Loss in per cent	1.12	1.22
Minutes required for melt	58	56
Cubic feet gas used	4,309	5,680
Degrees Fahr. gas temperature, average	130.3	142
Gas pressure in ounces	4	4
Metered gas per 100 lbs. metal melted.	293.1	386
Cubic feet gas corrected to 4 ounce pressure 60 deg. Fahr. per 100 lbs. metal	258.4	321.23
Cubic feet air metered	29,618	46,995
Air temperature, degrees Fahr.	118.3	133
Deg. Fahr. air temperature before entering pre-heating coil	118.3	.....
Deg. Fahr. air temperature after leaving pre-heating coil	458.8	.....
Degrees Fahr pre-heat	340.5	.....
Air pressure in ounces	32	14
Air metered per 100 lbs. metal melted.	2,015.5	3,193.6
Air corrected to 4 ounces and 60 deg. Fahr.	1,988.8	2,831.9
Ratio of gas to air, corrected values.	1:7.68	1:8.82
Per cent of copper in brass	79–81	79–81
Deg. Fahr. at which brass was poured.	2100	2100
Class metal melted	Ingot	Ingot
Size of casting, valves, inches	1 to 2	1 to 2
Kind of meter used, gas	Toby No. 4	
Kind of meter used, air	Westinghouse proport'nl	
Increased efficiency due to pre-heated air	19.7 per cent	

Data Sheet No. 3

	1 Pit tube 1¼-in. with 24 ⅜-in. holes.	2 Pit tube 1½-in. with 48 holes entering at right angles.	3 Pit tube 1½-in. with 48 holes slightly inclined upward.	4 Pit tube 1½-in. preheat coil of 30-ft. 2-in. pipe.
No. of melts	14	12	10	13
Metal wghd. in, lbs.	2,147.5	1,745	1,460	2,061
Metal wghd. out, lbs.	2,117.5	1,725	1,442	2,037
Loss in pounds.	30	20	18	24
Loss in per cent.	1.39	1.14	1.22	1.16
Min. required for melt.	58	56	51	46
Cubic feet gas used.	6,776	6,392	4,632	5,521
Deg. Fahr. gas temp.	91	91	91	88
Gas pressure in ounces.	4	4	4	4
Metered gas per 100 lb. metal	318	367	317	268
Cu. ft. gas corrected to 4 oz. press. and 60 deg. Fahr. per 100 lb. met.	298	344	297	253
Cu. ft. air metered.	56,510	27,560	36,300	46,051
Air temp. deg. Fahr.	92	118	118	95
Deg. Fahr. air tem. before entering preheating coil	.....	.....	.....	95
Deg. Fahr. air temp. after leaving preheating coil	.....	.....	.....	442
Deg. Fahr. preheat.	.....	.....	.....	347
Air pressure in ounces.	14	14	14	14
Air metered per 100 lb. metal	2,631	3,160	2,484	2,234
Air corrected to 4 oz. and 60 deg. Fahr.	2,567	2,908	2,285	2,163
Ratio of gas to air corrected values	1:8.61	1:8.45	1:7.69	1:8.55
Per cent of cop. in br's	79–80	79–80	79–80	79–80
Deg. Fahr. at which brass was poured.	21-2200 in all cases.			
Class of metal melted.	Ingot in all cases.			
Size of casting.	Valve in all cases.			
Kind of meter used, gas	Toby No. 4 in all cases.			
Kind of meter used, air	Westinghouse proportional in all cases.			
Increased efficiency due to preheated air.	14.8 per cent.			

Data Sheet No. 4

	Open flame furnace.
Number of melts	21
Metal weighed in, pounds	16,223
Metal weighed out, pounds	.....
Loss in pounds	.....
Loss in per cent	.....
Minutes required for melt	70
Cubic feet gas used	33,186
Degrees Fahr. gas temperature	85
Gas pressure in ounces	10
Metered gas per 100 pounds metal melted.	205
Cubic feet gas corrected to 4-ounce pressure and 60 degrees Fahr. per 100 pounds metal.	199
Cubic feet air metered	386,820
Air temperature, degrees Fahr.	100
Air pressure in ounces	14
Air metered per 100 pounds metal melted.	2,384.4
Air corrected to 4 ounces and 60 degrees Fahr.	2,191
Ratio of gas to air, corrected values	1:10.68
Per cent of copper in brass	79–80
Degrees Fahr. at which brass was poured	22–2,300
Class of metal melted	Ingot ½, Borings ½
Size of casting	Valve
Kind of meter used, gas	Toby No. 4
Kind of meter used, air	Westinghouse proportional

and the cost per melt was 6 cents, based on a price of 5 cents per number. The average life of the same size crucible used with oil and coke, given as 32 and 23 respectively, were taken from the Bureau of Mines' Bulletin No. 73, and, therefore, represent average practice throughout the United States. It will be noted that there is a saving per melt in crucibles of 3 cents over the oil-fired furnace, and of 7 cents over the coke-fired furnace, and these savings in crucibles per melt, represent a very considerable portion of the gas cost.

Assuming, for the sake of comparison, a 30 cent rate for gas containing approximately 1,000 British thermal units, the savings in crucibles when using gas, over the crucible cost when using coke, would be 7 cents per melt, thus making the gas cost 4 1/3 cents per 100 pounds of metal melted, assuming a consumption of 300 cubic feet per 100 pounds of metal.

Over a two-year observation, it was found that relining of gas-fired crucible furnaces was unnecessary, but they were repaired daily with a mixture consisting of carborundum sand, five parts; fire clay, one part and ganister, one-half part.

The average cost of these repairs per furnace, using the size 60 pot, was equal to $2.25 per month, this including the cost of replacing covers as needed. No expense for labor was charged as the labor involved is part of the regular duty of the furnace tender.

Of the furnaces tested, our experience shows that the non-tilting pit type equipped with chamber burner, is efficient in the consumption of gas, if high pressure of gas and air be maintained, and if the chamber burner be continually kept in good repair. However, this is very difficult, due to the warping effect, and the short life of the burner nozzle. Radiation losses from the chamber burner are high, leakage of gas is injurious to the furnace tenders and it is difficult to keep men to operate this type of furnace.

The furnace in which the body is elevated to remove the crucible, proves highly efficient, provided the air pressure is maintained at, approximately, two pounds. However, the cost of repairs would no doubt, be excessive as compared with the ordinary type, and the furnace developed several mechanical defects and was difficult to operate. The use of the split shank, would of course obviate the crushing strains upon the crucible produced by the tongs, but any increase in crucible life, which increase has not been demonstrated, to date, would be more than offset by the mechanical defects of the furnace.

Our experience has shown that where the shell or drum of the ordinary pit type of coke furnace is sufficiently large to allow a reasonable thickness of lining, this furnace equipped with a simple tube burner and pre-heating coils, which allows the use of low pressure gas and air, is as efficient as any of the more complicated furnaces tested. Its maintenance cost is practically nil, which applies to the burner also, and our experience shows that it may be continuously operated, without delay for repairs and with no inconvenience to operators. Owing to insufficient time available for experimentation, no conclusive data was obtained upon the open flame or furnace.

In comparing the melting cost of natural gas with other fuels, the following factors should be considered:

First.—The storage and labor cost of handling other fuels.

Second.—Storage space involved and in the case of oil, increased insurance risk, and added power cost, due to the necessity of pumping the oil under pressure, as also maintenance cost of pumps, and loss of time through the carbonization of oil, and stoppage of oil pipes and burners.

Third.—Money invested and interest on same, in fuels in stock.

Fourth.—Handling of ashes and the cost of recovering the metallic content of the ash and clinker.

Fifth. — Increased cost of crucibles with other than gas fuel.

The advantages of the use of natural gas are obvious. It may be stated that among its many advantages are:

First. — High quality of metal produced.

Second. — Decreased shrinkage loss, owing to ease of manipulation and regulation.

Third.—Small fuel cost per 100 pounds of metal melted, the saving in crucible cost alone amounting to a very large per cent of the cost of the gas.

Fourth.—Increased output of furnace per day.

Fifth.—Extremely small initial investment for equipment.

Sixth.—No storage of inflammable materials.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Porous Brass Castings

In making bronze pipe fittings weighing about 1,500 *pounds we have experienced considerable trouble from porosity. This extends to a depth of from ¼ to ⅜-inch on the outside, the remainder of the metal being sound. I have been using dry sand mold consisting of one-half molding sand, one-fourth sharp sand and one-fourth sawdust. Our mixture consists of copper,* 88 *per cent; tin,* 7 *per cent; phosphor tin,* 2 *per cent and lead,* 3 *per cent.*

The percentage of sawdust in the molding sand appears very high and it would be advisable to reduce it. It is usual to put some bonding material, such as flour, in dry sand mixtures to make a strong mold that will not crumble. The things to be desired in a dry sand mixture are permeability, strength and refractoriness. The first is attained by the addition of sharp sand or by using a naturally open sand. The second is secured by some glutinous substance which bonds the sand and the third by the use of sand low in such fluxes as magnesia, lime and iron. The porosity may be due to bad practice in melting the alloy and the chances are that this is the case. The copper should be melted under a cover of charcoal and when ready for the mixture, the phosphor-tin should be first added as this acts as a deoxidizer.

Mixtures for Bushings

We would like to have mixtures for the following alloys: Bushings, using scrap brass and scrap borings; yellow brass for bushings and hard red brass for bushings.

Making brass castings from scrap brass and borings is all guesswork unless the composition of the material is known and this is not possible with foreign scrap, that is, scrap that originated outside of the place where it is to be used. This guesswork is bound to result in loss and dissatisfaction sooner or later, owing to the fact that additions of other metals such as copper, tin, zinc, or lead which may be con-

sidered necessary, may fail to harmonize with the composition of the scrap, with the result that the castings may be entirely unfitted for the purpose for which they are intended. The composition of brass borings can seldom be determined without an analysis. They may be roughly divided into yellow and red borings and may be worked in, provided the castings required are low grade. For ordinary work, however, it is best to run the borings into ingots, after first removing the iron with a magnetic separator. Then an analysis of the ingots should be made after which they can be used intelligently. Scrap brass is a slightly different proposition, as it is seldom ingoted, and it is obviously impossible to analyze every piece. The selected scrap should be mixed with about 50 per cent new metal.

A fairly good composition for bushings consists of copper, 80 per cent; tin, 10 per cent and lead, 10 per cent. Of this alloy, 50 per cent may be used with 50 per cent scrap, or boring ingots.

An excellent yellow brass is made as follows: Copper, 79 per cent; zinc, 16 per cent; tin, 2 per cent and lead, 3 per cent.

Yellow Brass for Light Work

We are making small castings averaging ⅛-inch in thickness, but we experience considerable difficulty in getting sharp impressions. Our mixture consists of two-thirds ingot copper with one-third zinc, and phosphor-copper is used for the flux. We melt the ingot copper, add the zinc, stirring it thoroughly and leave the mixture in the furnace about five minutes. The phosphor-copper is added after the crucible is lifted out of the furnace. We have no method for ascertaining the temperature of the metal in our crucibles and we would like to have you take this into consideration in giving us advice on this subject.

The pouring temperature of yellow brass for thin castings can be ascertained easily by introducing a skimmer or thin iron bar into the crucible. If the metal is hot, a vibration will be felt and the metal should be removed from the furnace and poured as quickly as possible. In pouring yellow brass there must be no hesitation. The lip of the pot should be rested on the side of the flask and one quick, firm dip should fill the mold and the metal possibly should overflow on the floor. This is necessary to run thin castings and also in heavier work to prevent unsightly smoke streaks. If the castings in question are of uniform thickness, the addition of 2 ounces of aluminum per 100 pounds of metal will cause them to run sharp. If the castings have heavy sections, aluminum cannot be used on account of shrinkage. In this case the following alloy will be more satisfactory than the one you are using: Copper, 69 per cent; zinc, 26 per cent; tin, 2 per cent, and lead, 3 per cent.

Mixtures for Water Fittings

Kindly furnish me with the best and cheapest formula for elbows and tees for water fittings.

What is the difference between zinc and chloride of zinc?

If the fittings can be made of yellow metal, the following formula will be found satisfactory: Copper, 75 per cent; zinc, 21 per cent; lead, 2 per cent, and tin, 2 per cent.

If a red metal must be used, the following mixture can be employed: Copper, 85 per cent; tin, 5 per cent; lead, 5 per cent and zinc, 5 per cent.

The difference between zinc and chloride of zinc consists of the combination of the metal zinc with another element, chlorine, constituting zinc chloride. The latter consists of one atom of zinc and two atoms of chlorine and is entirely different in appearance and properties to either zinc or chlorine. It is used for soldering and forms an excellent flux for molten aluminum. Zinc oxide is another combination of the metal, zinc, but in this case the element, oxygen, is combined with the zinc. The fumes that emanate from molten yellow brass consist largely of zinc oxide and the same substance collects in the crucibles as they cool. It will be noted that this combination of zinc with another element is entirely different from the metal itself. Zinc has a bluish white color and its fracture is roughly crystalline.

Making Bronze Tablets

What mixtures are suitable for bronze tablets and how are they finished after they have been cast? What kind of paint is used for the background of the tablets and if they are lacquered, does this have to be baked on? Also, let me know if the tablets are finished the same for indoor as outdoor service.

The alloys used for bronze tablets are subject to considerable variation in composition. For example, one mixture used extensively follows: Copper, 90 per cent; zinc, 7.5 per cent and tin, 2.5 per cent.

Another alloy consists of copper, 90 per cent; tin, 7 per cent and zinc, 3 per cent. To every 100 pounds of this alloy add 8 ounces of lead.

A third alloy consists of the following: Copper, 90 per cent; tin, 5 per cent and zinc 5 per cent. To every 100 pounds of the alloy, add 8 ounces of lead. Tablets generally are given an oxidized finish and like all bronze work, the finish is rendered permanent by lacquering.

Mixture for Die-Cast Bearings

Will you kindly send me a formula for making die-cast bearings for gasoline engines?

The following formulas will afford a selection of a suitable alloy for the purpose outlined:

No. 1.—Copper, 10 per cent; zinc, 83 per cent; aluminum, 2 per cent and tin, 5 per cent.

No. 2.—Copper, 3 per cent; zinc, 87 per cent; tin, 5 per cent and antimony, 5 per cent.

No. 3.—Copper, 5 per cent; zinc, 75 per cent; aluminum, 5 per cent and tin, 15 per cent.

Copper Melting Difficulties

We would like to obtain some information regarding the mixture of scrap copper with brass. We do railroad work largely and our raw material is in the form of scrap brass which has been melted over so many times that it now seems to need something to soften it. Recently we received a lot of scrap tubing cut into sections about 3 inches long, but we have had little success in mixing it with the brass, although we have tried several ways to accomplish this. First, we charged the copper and brass together, but even at a high temperature the metal would not melt. Next we melted a bath of brass and added the copper gradually to the molten brass which was at a white heat. The surface of the metal was covered with charcoal and as the copper was charged the bath was thoroughly stirred, but in spite of all efforts, the copper would not melt and mix with the brass. Is the copper so much harder to melt than ordinary brass that it will not dissolve or what is the cause of our difficulty?

Any furnace that will melt brass and which is capable of raising this alloy to a white heat also will melt copper. We would suggest that the copper be tested with a magnet to ascertain whether it is not copper-clad iron tubing in place of solid copper. If this is the case, the reason for its failure to melt will be plain, but if the tubes happen to be solid copper, the difficulty undoubtedly lies with the furnace. In this event the brass will not be white hot, but cherry red and mushy. Even at that, some of the copper should be dissolved, as this metal will dissolve in molten zinc. A trial might be made of melting the copper first and this will determine whether the temperature of

the furnace is sufficiently high to melt copper. If this fails, there is no use trying to cast brass, as the temperature of the latter when ready to pour usually is higher than the melting point of copper.

In mixing brass and copper, some definite scheme should be followed. For instance, if a 100-pound charge of brass is required and if half of this is to be scrap brass, the addition of 50 pounds of copper will change the composition of the resulting alloy from that of the original brass and it is highly probable that it will be entirely unsuited for the kind of castings to be made. The copper will have to be alloyed even when mixed with brass and a suitable alloy probably will be copper, 85 pounds; tin, 5 pounds; zinc, 5 pounds, and lead, 5 pounds. Therefore, for 50 pounds you take half of this formula, or copper, 42½ pounds, which is melted with the brass under a cover of charcoal and when thoroughly fluid, the remaining metals are added, namely, 2½ pounds of zinc, 2½ pounds of tin and 2½ pounds of lead. If the scrap brass has been repeatedly remelted, an addition of ¼-pound of 15 per cent phosphor-copper for each 100 pounds of metal should be made. The object of using phosphor-copper is to deoxidize the metal and to restore it as far as possible to the condition of new metal.

Nickel and Hydraulic Bronzes

Will you kindly furnish us with a mixture for nickel bronze for bearings and also a hydraulic bronze mixture?

The formula for a nickel bearing bronze follows: Copper, 80 per cent; tin, 9 per cent; nickel, 2 per cent; lead, 8 per cent and phosphor-tin, 1 per cent.

Both of the following alloys are used extensively for hydraulic purposes:

Copper, 80 per cent, tin, 11 per cent and yellow brass, 9 per cent.

Copper, 90 per cent; tin, 5 per cent and 5 per cent phosphor-tin, 5 per cent.

High Tensile Manganese Bronze

We should like to have a formula for manganese bronze that will withstand a tensile test of 28 tons per square inch and will have 15 per cent elongation in 2 inches.

The following alloy will be found to answer your requirements: Copper, 56 pounds; zinc, 40 pounds; aluminum, ½ pound and a steel alloy, 2 pounds.

This steel alloy is made as follows: Melt together 18 pounds of wrought iron and 4 pounds of 80 per cent ferro-manganese and add gradually and in small pieces, 10 pounds of tin, stirring thoroughly, the entire mixture being cast into ingot form. The steel alloy is brittle and can be broken into small pieces conveniently for making weights. The ingots, however, should be of small section. In making the manganese bronze, first melt together a portion of the copper constituting the charge, with the required amount of steel alloy, and superheat the copper until the steel alloy is entirely dissolved. This is not at all difficult as the melting point of the steel alloy is comparatively low on account of the high tin content. When the alloy is dissolved in the copper, add the remainder of the latter, then the aluminum and follow with the zinc. A temperature higher than ordinary will be required to melt the steel alloy, owing to the high melting points of iron and ferro-manganese. If this high temperature cannot be obtained with the available furnaces, the bronze can be made just as well by the following method: Melt 50 per cent of the copper charge, superheat, add 1.25 per cent of bright, clean tin plate and use ¼-pound of bicarbonate of soda as a flux. Stir in the tin plate, which readily will dissolve in the hot copper, add the aluminum, then the balance of the copper. When the latter has been melted, add ½-pound of 30-per cent manganese-copper, stir well, add the zinc and then ¾-pound of tin.

Cracked Bearings

We are making bearings weighing 35 pounds, but cracks develop in the inner surface and at the square edges. These bearings were poured with a mixture consisting of 40 pounds of sheet copper, 60 pounds of brass scrap and 3½ pounds of phosphor-tin. We would like to know the cause of this contraction and if necessary, we would be pleased to have you advise a better mixture.

We suggest that the mixture be changed to the following: Copper, 40 pounds; scrap, 54 pounds; tin, 3 pounds; phosphor-tin, 2 pounds and lead, 3 pounds. Charge the copper and the scrap in the crucible and if the latter will not contain the entire charge, use a crucible ring or *jumper* on top of the pot and pile the balance of the charge into this ring. On top of the charge place sufficient charcoal to entirely cover the bath of metal when it is melted. When the charge is molten, first add the phosphor-tin, which will deoxidize the metal bath, then add the tin and last the lead; stir thoroughly, preferably with a graphite stirrer. Pour the metal into the molds while it is still very hot and as soon as the castings are cooled below a red heat, shake-out the molds and clean off the fins with a heavy file or spade. Also, it will be advisable to scrape the castings, while hot, with the file. A crucible ring can be made by chopping the bottom off an old crucible. If the mold is made bearing down, use a high cope, building up the head at least 6 inches higher than the top of the pattern. If the casting is molded bearing up, the metal can be poured cool, providing a heavy feeder is used to prevent shrinkage. Your difficulty in this instance can be attributed to shrinkage entirely.

Brass Pattern Runner

Can you recommend a mixture for a brass pattern runner that can be bent and withstand rapping? What soldering mixture can be used for soldering No. 12 aluminum? Is there anything that can be mixed with aluminum powder so that it can be used for filling cracks in aluminum castings?

The following alloy will be found satisfactory for making brass runners that can be bent and will withstand hard usage: Copper, 87 per cent; tin, 6.5 per cent; zinc, 3.5 per cent and lead, 3 per cent.

For soldering aluminum, the following alloy is frequently used: Aluminum, 1 part; phosphor tin, 1 part; zinc, 11 parts and tin, 22 parts.

To fill cracks in aluminum castings use white lacquer as the medium for converting the aluminum powder to the required plastic condition.

Use of Scrap Metals

We have been making some manganese bronze castings, very rarely using any new copper. This mixture consists entirely of old and new castings. The castings have holes in them and look as if they may have been burned. Is this trouble due to the absence of new metal in the mixture? Some of our old stock comes from a university where they do some experimenting. Also kindly give me a formula for aluminum castings about 3½ feet long, 16 inches wide and ⅜-inch thick. It must take a high finish. Kindly advise how this metal should be treated.

There is no doubt but that the scrap is the cause of your difficulty. Scrap manganese bronze is poor material, owing to the fact that there may be some question as to whether it is manganese bronze at all. If the metal is as suspected, namely, burned, the addition of a little manganese may help. The manganese can be added conveniently in the form of manganese zinc, using only ½ of 1 per cent of the alloy containing approximately 22 per cent manganese. If this is not available, dilute any quantity of 30 per cent manganese-copper with twice its weight of zinc and add 1 per

cent of the molten manganese bronze. Metal which has been experimented with also is to be regarded with suspicion, as it may have been mixed with some metal or metalloid, for example, selenium or tellerium, which is capable of causing considerable difficulty in the foundry. A suitable formula for an aluminum alloy follows: Aluminum, 92 per cent, and copper, 8 per cent.

Machine-Made Cores

By W. D. Fraser

For a considerable period we experienced great difficulty in making small stock cores in large quantities. The cores are 2 inches in diameter and 15 inches long and should be soft and porous. Two of these are placed in a snap flask mold made on a stripping plate machine and since our output averages 600 molds per day, we have to provide 1,200 cores.

In Fig. 1 is shown the finished drag with the cores in place. The cope is set on edge above the drag, while at the left is shown a rough casting before it has been cleaned. This likewise illustrates the method of gating. If the cores are slightly hard, the cope side of these rings contain blow-holes and frequently the casting is only a shell. The cores are made on a screw type machine and are dried in a drawer type core oven. For a considerable period we experimented with core mixtures and finally have adopted the following: Fifty parts of lake sand, 12 parts of burnt molding sand brushed from the castings before rattling, six parts of coke breeze, six parts of old sand recovered from broken cores and five parts of glutrin mixed in the proportion of 15 parts of glutrin to 10 of water. This mixture is run through a No. 4 riddle and is then shoveled into a sand mixer where the glutrin water is added. By the use of this mixer the amount of glutrin required was reduced practically 50 per cent. A corner of our core room where the stock cores are made is shown in Fig. 2. Ample power is furnished by a five-horsepower motor.

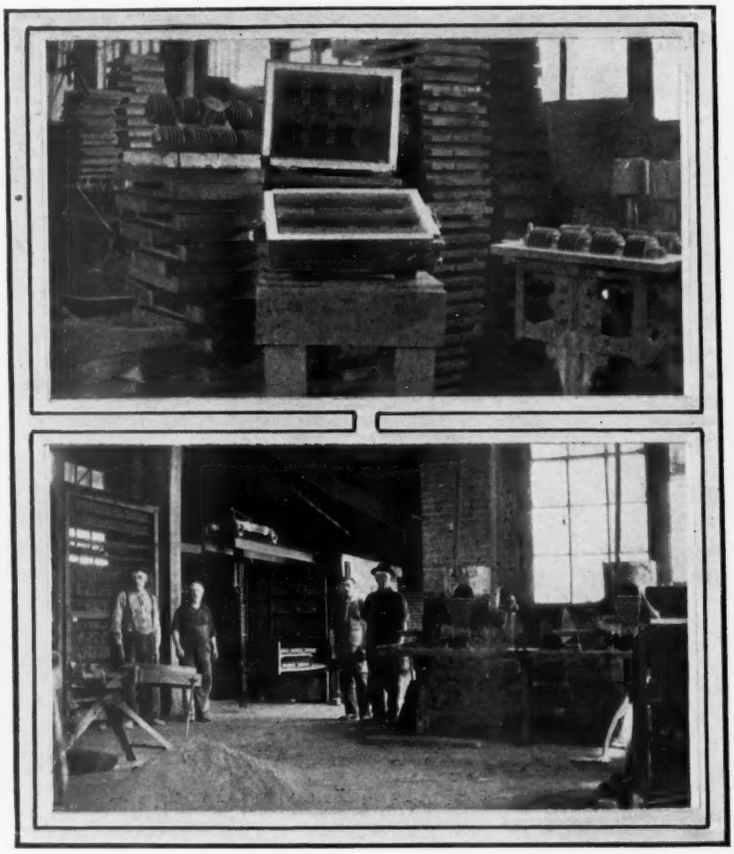


FIG. 1—DRAG AND COPE OF MOLD SHOWING LARGE CORES
FIG. 2—THE CORE ROOM

Titanium Aluminum Bronze

Titanium aluminum bronze, a new alloy developed by the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., is discussed in an eight-page booklet recently issued. The Titanium company, after extensive research, has developed special processes for the manufacture of this aluminum bronze, which include the use of titanium as a deoxidizer. The 10 per cent titanium aluminum bronze has an ultimate strength, per square inch, using standard test bars, of 70,000 pounds; 20 per cent elongation in 2 inches; specific gravity of 7.5; co-efficient of friction, 0.0018; Brinell hardness number from 90 to 100; linear contraction, 0.22-inch per foot, and a compression, 1,000 pounds load per square inch, of 12 per cent. It is well known that aluminum bronze mixtures are not readily corrodible by sea water, hold a fine surface when exposed to the weather and work well generally. The Titanium Alloy Mfg. Co., in addition to specializing on aluminum bronzes, manufactures a general line of brass and bronze castings.

Leonard C. Wason, president of the Aberthaw Construction Co., Boston, who recently was elected president of the American Concrete Institute, has offered a new prize to be awarded annually by the institute to the author of the best paper submitted to the institute during the year. Competition is restricted to members and the paper must be original in every respect and must not previously have been published elsewhere.

Shot in Gray Iron

By W. M. Carr

Since the discussion of shot in gray iron by R. A. Pitman in the March issue of *The Foundry*, page 103, confirms my own observations, these lead naturally to the suggestion of means to prevent the occurrence of shot. Top-pouring of molds is a prolific cause of this difficulty and the most logical step seems to point to bottom-pouring. In the latter plan, if an extended space or a well be formed at the bottom of the gate in order that the splashes of metal caused by the stream falling from a height be confined to that space, the danger of shot reaching the mold would be lessened materially. This method would increase the percentage of gates and sprues, but if the rejection of castings because of shot be reduced, the modified gate suggested would be an economy.

Lumber

Lumber is the title of a 12-page house organ published by the Thomas E. Coale Lumber Co., Bellevue Court building, Philadelphia. The publication is devoted to "preferred forest products" and contains considerable interesting information on the use of white pine for patterns. To meet the requirements of the pattern shop the white pine offered by the Coale company is well selected stock. Spruce is offered for foundry flasks, being smooth-working, easy-cutting and at the same time it is of a consistently uniform quality.

The journal contains a large amount of interesting information on lumber adapted for the foundry and pattern shop.

Making Small Gear Wheels by a Novel Method

How a Molding Machine is Employed for Doing This Work, With Details of the Stripping-Plate Equipment

By R A Miles

CASTING small, toothed wheels in quantities always has been a source of worry to foundry managers and superintendents. The high cost of production caused by the very low output of these castings, when made by skilled artisans on the bench, to say the least, is very annoying. This problem, however, has been attacked in a Lancashire (Eng.) foundry and after careful thought and many experiments, excelled results have been obtained.

Two molding machines were installed, made by the Adaptable Molding Machine Co., Birmingham, Eng., and rigs were made suitable for the job. The patterns range from wheels with 16 teeth, 1¼ inches in diameter, to wheels with 75 teeth, 6¼ inches in diameter, all ⅞-inch wide. The wheels with 16 teeth and up to 31 teeth inclusive are made flat on both sides, as shown in Fig. 7. All the wheels with more than 31 teeth are recessed somewhat, each pattern having the same thickness of allowed metal from the edge of the tooth to the recessed part and sufficient metal is allowed on each wheel to form a boss, as shown in Fig. 8.

The lift table, Fig. 5, has been arranged to take any set of wheel patterns in the foregoing range. Wheels containing 16 to 31 teeth inclusive are made eight in a flask; 32 to 50, four in a flask; 51 to 60, two in a flask and 61 to 75, one in a flask, the same snap flask being suitable for these sizes.

All the wheels are cast solid and have to be bored out ⅝-inch in the center. In making the lift table, Fig. 5, extra thickness was allowed for machining and the holes for screwing to the machine are countersunk to leave a level surface when fixed in position. Each separate set of patterns has its own matrix plate, Fig. 6. These plates are made so that in planing, one cut only is necessary on each side and all are finished one thickness, namely ⅞-inch. The underside of these plates has

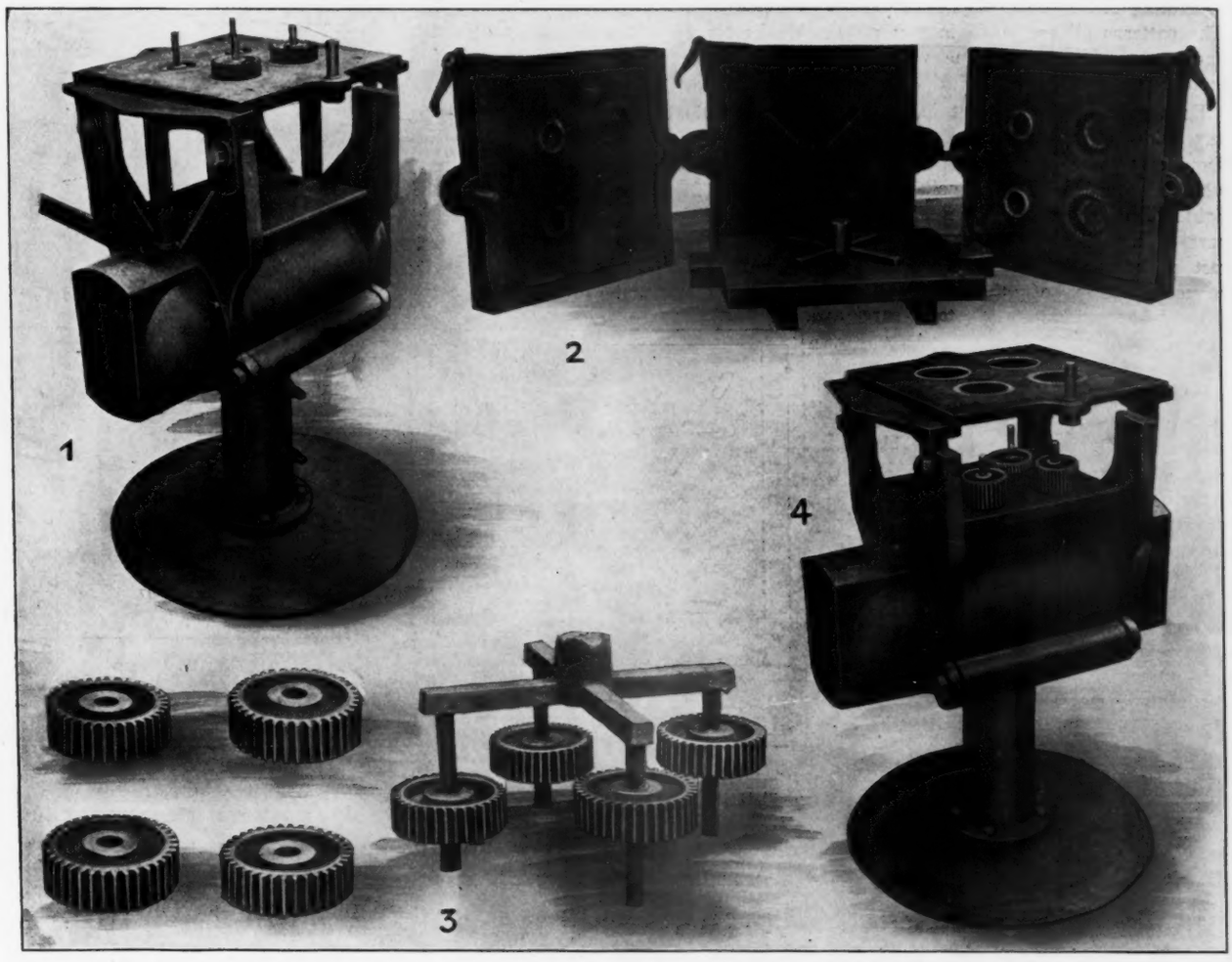


FIG. 1—MACHINE IN POSITION FOR RAMMING DRAG OR COPE

FIG. 2—THREE PARTS OF THE MOLD SHOWING COVERED RUNNER IN THE CENTER

FIG. 3—FOUR CASTINGS WITH RUNNERS ATTACHED. THE FINISHED GEAR WHEELS ARE SHOWN AT THE LEFT

FIG. 4—MACHINE SHOWING PATTERN STRIPPED

two facings which rest on the fixed portion of the machine and each plate is fastened by four screws, one at each corner. The whole of the matrix plates were cast from one iron pattern made suitable by changing core prints and 10 changes of core boxes were required. This method obviated machining the grooves by which the matrix metal is held in position. A number, corresponding with the number of teeth in the patterns used with each separate plate, is cast on the underside. The patterns all are made in gun metal and are machined the same width, the teeth being cut.

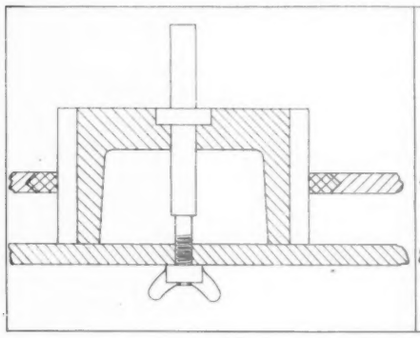


FIG. 5—PLAN AND SECTIONAL VIEWS OF LIFT TABLE

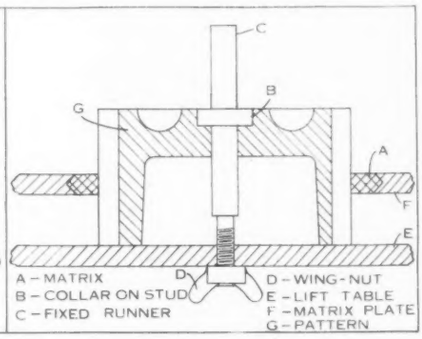


FIG. 6—PLAN AND SECTIONAL VIEWS OF MATRIX PLATE

Each pattern is bored out in the center with a special tool, leaving a shoulder to receive the stud, *B*, Fig. 6, which is turned with a collar to fit tight. The runners or gates also form part of the stud, shown at *C*, and are cast on both sides of the wheels. The runner portion of these studs are slightly tapered in order to insure a clean draw.

These studs were carefully turned and are perfectly interchangeable, four of them being made long enough for the patterns and four to suit the blanks, each, of course, being the same length overall. In assembling the patterns, which are numbered on the underside to correspond with the number near the holes in the lift table, Fig. 5, the patterns, *G*, Fig. 6, are first dropped through the matrixes and then the studs are placed through the holes in the centers of the patterns, being afterwards made secure by the wing nuts, *D*, Fig. 6, underneath the lift table. Access to these wing nuts is easy from the sides of the machine. A recent time test when changing from one set of patterns to another recorded exactly three minutes.

Each matrix plate is drilled $\frac{7}{8}$-inch in the center and is then placed on a peg which is fixed on a jig to bore out the holes for the pin and pin hole. This jig has holes in it similar to those in the lift table and when each set of patterns is placed in correct position, the jig, matrix plate and pattern are warmed in a stove, the matrix metal being poured when they are quite hot, thus securing a good, sharp matrix. Ordinary anti-friction metal was used for these matrixes and has proved to be satisfactory.

These wheels shown in Fig. 3 are $3\frac{1}{8}$ inches in diameter and have 36 teeth. Only two patterns are used to produce four castings, drag and cope being rammed up on the same machine, but as these patterns are recessed, the reverse side is made by inserting two blanks turned out and fixed to the lift table in the same manner as the full pattern.

The castings are made in a three-part snap flask measuring 12 x 12 inches inside, the drag being $2\frac{1}{2}$ inches deep, the cope 2 inches deep and the top part, which is used to contain a covered runner, is also 2 inches deep.

The molds are carried off on light cast iron plates and are placed close together on the foundry floor. No bands or slip jackets are necessary, but flat weights are used when pouring. Fig. 1 shows the machine in position for ramming the drag or cope. The runners on the patterns being fixtures are consequently cast on both sides of the wheels. These runners are just the height of the cope and the molder after ramming strickles the sand off level with the edge of the flask, which then clears the runners. The covered runner portion of the mold is rammed up on a board which is shown in center of Fig. 2, with the drag at the right and the cope at the left. Fig. 4 shows the machine with the patterns on the lift table withdrawn.

In Fig. 3 four castings are shown with the runners attached and four finished castings are in the foreground. It will be noted that the runners on the castings which are in the cope portion of the mold are thicker in diameter than those in the drag. This was found necessary owing to the castings in the cope running light, but after increasing the thickness of these runners a uniformity of correct teeth has resulted.

In making these castings on the bench the molders use a horn runner to each casting and the time spent in setting these horn runners and drawing them out of the sand is alone more than is required to make a complete mold containing as many wheels by any semi-skilled laborer on these machines. A recent time test showed a big margin in favor of the machine-made wheel, a complete mold of eight wheels being made ready for casting in three minutes, as against $12\frac{1}{2}$ minutes on the bench.

At the annual meeting of the St. Louis Foundrymen's Club, held at the Marquette hotel, St. Louis, Saturday, March 13, officers were elected as follows: President, H. S. Gulick, More-Jones Brass & Metal Co.; vice president, H. G. Smith, mechanical engineering department, Washington University; treasurer, W. G. Roepke, Commonwealth Steel Co., Granite City, Ill., and secretary, C. Roy Rook, U. S. Incandescent Lamp Co.

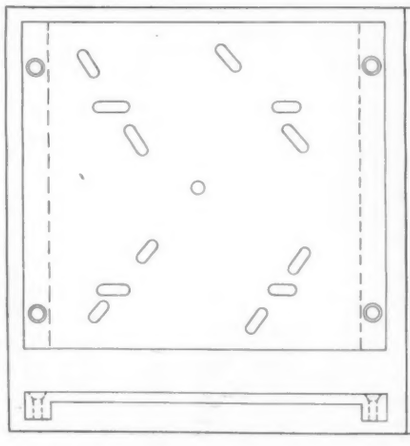


FIG. 7—SECTIONAL VIEW OF PATTERN AND PLATE FOR WHEELS WITH 16 TO 31 TEETH

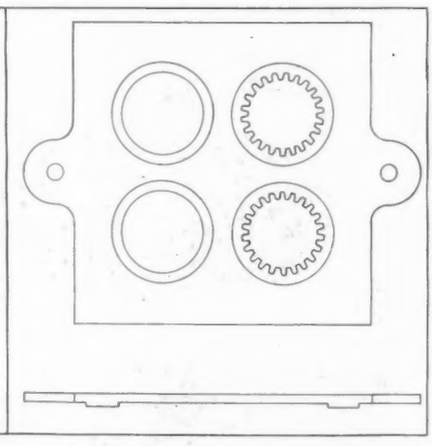


FIG. 8—SECTIONAL VIEW OF PATTERN AND PLATE FOR WHEELS WITH MORE THAN 31 TEETH

Atlantic City Meeting of American Foundrymen

Tentative Program of the Annual Meeting of the American Foundrymen's Association—Entertainment Features

THE annual meeting of the American Foundrymen's Association will be held at Atlantic City during the week of Sept. 27, with headquarters at the Marlborough-Blenheim hotel. Business and technical sessions will be conducted on Young's steel pier, almost directly opposite the Marlborough-Blenheim. The exhibit of foundry equipment and supplies under the auspices of the Foundry & Machine Exhibition Co., will be held on the steel pier and will open Saturday, Sept. 25. A tentative program of the meeting already has been adopted, as follows:

Monday, Sept. 27.

Registration; headquarters Young's steel pier.

Tuesday, Sept. 28.

10:00 A. M.—Opening session, joint meeting between the American Foundrymen's Association and the American Institute of Metals.
2:00 P. M.—Operating session.
8:00 P. M.—Entertainment for members and ladies of the American Foundrymen's Association and the American Institute of Metals.

Wednesday, Sept. 29.

10:00 A. M.—General topics, joint session between the American Foundrymen's Association and the American Institute of Metals.
2:00 P. M.—Gray iron session.
8:00 P. M.—Business session, annual address by president, election of officers, etc.

Thursday, Sept. 30.

10:00 A. M.—Simultaneous sessions on steel and malleable iron.
2:00 P. M.—Simultaneous sessions on steel and malleable iron.
7:00 P. M.—Annual banquet.

Friday, Oct. 1.

10:00 A. M.—Final business session.

It will be noted that this tentative program provides for two sessions for the discussion of cast steel and two meetings will be devoted to malleable iron. At the last meeting held at Chicago insufficient time was allotted for the discussion of the many valuable papers presented and to enable those who are interested in these topics to discuss the papers at length, two sessions will be devoted to steel and malleable iron, respectively. The change in the session at which officers are elected was made for the purpose of giving the new officers an opportunity to meet prior to the close of the convention for the purpose of outlining the ensuing year's work.

The papers committee already is actively at work on the program obtaining contributions and any member desiring special topics discussed should send his suggestions either to the secretary, A. O. Backert, Cleveland, or to Harry B. Swan, chairman of the papers committee, Cadillac Motor Car Co., Detroit.

Revision of Constitution and By-Laws

The proposed revision of the constitution and by-laws, passed to letter ballot at the Chicago meeting has been favorably acted upon, 103 ballots having been cast in favor of the revision and 3 against. The principal changes provide for an entrance fee after May, 1, 1915, of $10 for active members and $5 for associate members.

The Associated Foundry Foremen have given up their charter and all of the members in good standing are now affiliated with the American Foundrymen's Association as associate members. The total number added to the enrollment is 102, thereby increasing the total membership of the society to nearly 1,000, the highest mark attained since the organization of this society.

The Society Emblem

In view of the fact that no emblem of the society was ever officially adopted, President R. A. Bull appointed an emblem committee immediately following the convention, which consisted of A. O. Backert, Cleveland, chairman; Thomas D. West, Benjamin D. Fuller, H. Cole Estep and R. A. Bull, president (ex officio). Numerous designs were prepared and submitted for consideration, resulting in the adoption of an emblem which incorporates the principal tools of the molder, namely the shovel, the rammer and the trowel. Also, it was decided to reproduce this emblem in the form of a pin and these now are available to the members in gold and black enamel at a price of $2 each. These buttons can be obtained by addressing the secretary, A. O. Backert, Twelfth and Chestnut streets, Cleveland, O.

The A B C of Iron and Steel

THE A B C of Iron and Steel with a directory of the iron and steel industry, written by the collaboration of 16 authors and edited by A. O. Backert; 354, 8 x 11-inch pages, bound in cloth or leather; 222 illustrations; issued by The Penton Publishing Co., publishers of *The Iron Trade Review*, Cleveland; furnished by *The Foundry* for $5 postpaid.

Although the literature of the iron and steel industry is extensive, practically all of it is of a technical nature which presupposes a considerable knowledge of all branches of the business on the part of the reader. The industry, however, is so large and its ramifications so extensive that there are a great many persons connected with it who have had no opportunity to become personally familiar with all of its phases. Also, there are a large number of people in various walks of life who are anxious to become familiar with the methods and processes of one of the world's greatest industries. Every well educated man, be he engineer, attorney or salesman, should have a broad, practical knowledge of the whole scope of the iron and steel business. For this reason, the demand for an elementary work covering not only the practical, but the commercial phases of the industry has been insistent. It is for the purpose of meeting this demand that *The A B C of Iron and Steel* is offered. This volume is intended to furnish a simple, concise, but at the same time comprehensive exposition of the primary processes involved in the conversion of iron ore into finished forms. Its scope is accurately indicated by its title. No effort is made to furnish an exhaustive treatment of the subject; instead, the aim is to present the leading facts regarding the manufacture of iron and steel in graphic, readable language, free from technicalities. The subjects are treated in natural sequence. Five chapters are devoted to iron ore, covering thoroughly mining operations, beneficiation, transportation, handling problems and valuation. Separate chapters are devoted to beehive and by-product coke. Following this, the book takes up the manufacture of pig iron, wrought iron, crucible steel, bessemer steel and open-hearth steel. After covering the manufacture of the primary materials, their conversion into finished forms is considered and chapters are presented on the rolling mill industry, on wire and wire rods, gray iron, malleable and steel castings, and on electric steel.

Each process is described by a man who is a recognized authority on the principal subject on which he writes—

an established leader in his field. The book, therefore, represents the thorough knowledge and years of practical experience of the foremost men in every branch of iron and steel making. The authors include such men as John Birkinbine, Philadelphia, the leading authority on iron ore; Kenneth Seaver, chief engineer, Harbison-Walker Refractories Co., Pittsburgh; F. H. Kindl, consulting engineer and former partner of Andrew Carnegie; Kenneth B. Lewis, manager of the wire drawing department of the Morgan Construction Co., Worcester, Mass., and R. A. Bull, manager of production, Commonwealth Steel Co., St. Louis, and president of the American Foundrymen's Association. In dividing the work among a number of contributors, instead of presenting a volume embodying ideas of a single author, who would necessarily have a somewhat limited vision regardless of his capabilities, an opportunity was created to present each subject in an adequate, comprehensive and accurate manner. At the same time the reader receives the benefit of a variety of viewpoints.

It is a common-sense book written expressly to fill the needs of every man affiliated with or in any way interested in the iron and steel industry. Technical language and long discussions of mechanical details have been carefully avoided; each chapter is written in simple everyday English. Nevertheless, an effort has been made not to sacrifice accuracy and completeness for the sake of simplicity.

To show the commercial as well as the manufacturing progress of the iron and steel business, several pages of statistical matter are presented covering the production, the imports and the exports of every iron and steel product from earliest records down to the present time.

The shipments of iron ore from each of the mines on the Lake Superior ranges also are carefully tabulated, thus furnishing a complete statistical survey of the growth of the iron and steel business in the United States.

The book also includes a directory of the iron and steel works of the United States and Canada, giving the names of companies, their products and the names of their officers. The directory is classified according to names of companies, and also according to products. It was carefully compiled from original data collected during the closing months of 1914 and was revised up to the time of going to press. It therefore constitutes the only complete, up-to-date directory of the iron and steel business in existence, giving not only the names of the companies and what they manufacture, but the names of their executives, including purchasing agents. An effort has been made to treat the entire subject along lines that are essentially American, it being the intention of the publisher to present a book which will serve to epitomize the progress of the iron and steel industry in the United States.

The Electric Furnace in the Foundry

By William G Kranz

THE increased service demands on some of the products of the National Malleable Casting Co., prompted it about eight years ago to investigate the electric furnace, both in America and in Europe. The process had already been sufficiently developed in Europe to lead us to believe that the electric furnace would most nearly meet our requirements. After further investigation and consultation with authorities on the subject, we decided upon the Heroult type as simple and practicable. In 1910, we built a furnace of this type, of 300 pounds capacity, for experimental purposes, and although it was crudely constructed the quality of the material we were able to make justified the installation of a 6-ton Heroult furnace in 1912. This furnace has three electrodes, 17 inches in diameter, uses three-phase, 60-cycle current, and is equipped with Thury regulators, which give us good regulation and a uniform load on the line even when cold melting. The power factor of the furnace is 94 per cent.

Since July, 1912, the furnace has been in continuous operation, producing up to the present time over 20,000 tons of both carbon and alloy steels of varying analyses and of exceptional quality. Both cold and hot metal charges have been used, with a power consumption of about 150-kilowatt-hours per ton in the case of hot metal charges and from 500 to 600-kilowatt-hours per ton in the case of cold charges.

The electric energy consumed varies according to the final analysis of the steel and the amount of refining required. Too much cannot be said about the refining possibilities of the electric furnace, for it is believed no other method of steel manufacture can compete with the electric in this respect.

In proper operation lies the whole secret of success. That steel has been made electrically means nothing, for when the furnace is operated under oxidizing conditions the quality is no better than that of open-hearth material; but when properly made, electric steel is as good as that made in the crucible, and very much less expensive. The operation of the furnace is simple and the resultant composition is scientifically accurate. For example, on a heat of steel treated under a slag of high-silica content some metallic aluminum was added in order to reduce the silicon from the slag in accordance with the following chemical equation:

$$3SiO_2 + 4Al = 3Si + 2Al_2O_3.$$

Upon final analysis it was found that the amount reduced was theoretically correct in accordance with the foregoing equation.

The most important of the many advantages of electric steel castings are briefly summarized below, and it should be kept in mind that these apply not only to carbon steels but to the alloy steels as well:

1.—Absence of segregation, elimination of oxides, and uniformity of composition regardless of atmospheric conditions which affect open-hearth furnaces.

2.—Almost entire elimination of sulphur is possible (an important consideration in steel castings) and complete control of the other elements.

3.—Great tenacity, giving ability to withstand much abuse and fatigue without rupture.

4.—High ratio of elastic limit to ultimate strength.

5.—A ready response to heat treatment, with uniform results.

6.—Perfect control of pouring temperature, combined with ability to obtain very hot metal, so that light and intricate shapes are readily cast.

Let us take up the more important of these qualities of electric steel, and investigate them more fully. Absence of segregation and oxides has been firmly established by a great many investigations in our chemical and microscopical laboratories. As a more practical proof of the elimination of oxides, we know that additions of any of the ferro-alloys to the bath will be found alloyed with the steel in their theoretical amounts.

This is found even to be the case with elements, such as aluminum and titanium, which are so susceptible to oxidation, proving conclusively in our

A paper to be presented at the San Francisco meeting of the American Institute of Mining Engineers, September, 1915. The author, William G. Kranz is manager of the Sharon, Pa., plant of the National Malleable Castings Co.

minds that there could be no oxygen present in the steel. Leading authorities have agreed for some time that the electric steel furnace affords means of preventing segregation. W. R. Walker, in May, 1912, read a paper on electric steel rails before the American Iron and Steel Institute, in which he stated that, "Ingots of even eight tons had been produced electrically which were practically free from segregation."

We know of no authority who doubts the practical elimination of sulphur in electric-furnace operation. We have repeatedly reduced the sulphur to a trace in irons containing as high as 0.30 per cent sulphur. The rapidity with which this reduction takes place depends somewhat upon the carbon content of the material, the sulphur reducing very much more rapidly in the higher carbon materials.

To illustrate the tenacity of electric steel we made tests of two similarly treated specimens of steel on an Upton-Lewis toughness testing machines. One of these was electric and the other open-hearth. The electric steel showed the following composition: Carbon, 0.24 per cent; manganese, 0.52 per cent; silicon, 0.25 per cent; phosphorus, 0.010 per cent and sulphur, 0.019 per cent. The steel exhibited the following physical qualities:

Elastic limit, pounds.....	36,400
Ultimate strength, pounds....	65,300
Elongation, per cent.....	36
Reduction, per cent.....	55
Toughness test (fatigue) to break, cycles	345

The basic open-hearth steel analyzed 0.23 per cent carbon, 0.53 per cent manganese, 0.24 per cent silicon, 0.011 per cent phosphorus and 0.038 per cent sulphur. It showed the following physical characteristics:

Elastic limit, pounds.....	34,800
Ultimate strength, pounds....	63,000
Elongation, per cent.....	29½
Reduction, per cent.....	35
Toughness test (fatigue) to break, cycles	213

The foregoing figures are typical of a large number of tests.

During the past year we have developed an electric steel having remarkable physical qualities after heat treatment. This was accomplished without resorting to any of the high-priced alloys. The steel, when subjected to shock or static pull, will stand from four to five times as much stress without distortion as the ordinary open-hearth product. This assertion is not based on a few tests, but on over 3,000 made up to the present time.

We have made a great many similar tests of heat-treated open-hearth material, and have found that in certain specimens the physical properties are impaired by the treatment rather than benefited. This is not, however, the case with the electric-furnace product. The old saying that "In order to make good bread you must start with good dough," we believe applies to the steel industry as well.

A great advantage of the electric-furnace process is its uniformity of product. The open-hearth under certain conditions will, we know, produce steel of very good quality, but there are so many contingencies, such as atmospheric conditions, stack-draft, fuel and furnace variations, beyond the control of the operator, that absolutely uniform results are difficult of attainment.

Electric-furnace products are looked upon by some with skepticism, due to those who have adopted the process thinking it a panacea for all of their ills, and have furnished the trade with steel not worthy of the name. The lack of knowledge and the inexperience of the operator should in no way condemn the process. The production of perfect castings does not entirely depend upon the quality of the material of which they are made, but upon the foundry practice to a very great extent. Frequently excellent material is ruined by bad foundry practice. Nevertheless we feel that the electric furnace, with its excellent control of composition and temperature, fills a long-felt want in the industry.

Personal

E. J. Vatier has been appointed foreman of the Sterling Bronze Co.'s plant, New York City. He formerly had charge of the Newark Art Foundry.

C. H. Schmalz has been appointed manager of the Billings Foundry & Mfg. Co., Billings, Mont. He formerly was assistant master mechanic for the Boston & Montana smelting department.

Charles Stewart, formerly with the Lisk Mfg. Co., Canandaigua, N. Y., has been appointed superintendent of the foundry and machine shop of the Dwasgo Mfg. Co., of the same place.

John D. Miller, formerly with the Wheeling Mold & Foundry Co., has been appointed general manager of the foundries operated by the Edward Maher's Sons Co., Newark, N. J.

Major Joseph T. Speer has been elected chairman of the board of directors of the Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, to succeed Henry M. Atwood, who resigned last October.

Edward J. Kaufman, formerly in charge of the foundry operated by the Steacy-Schmidt Mfg. Co., York, Pa., has resigned to accept the position of foundry foreman with the Frick Co., Waynesboro, Pa.

George Hills has been placed in charge of the arc welding department of the Burke Electric Co., Erie, Pa. Complete welding systems are manufactured for use in steel foundries, rolling mills, railroad repair shops, boiler and tank works, etc.

Malleable Iron Difficulties

By J. P. Pero

In the March number of *The Foundry*, page 120, W. J. Keep, in discussing malleable iron difficulties, says the following: "There is little strength to the heart of malleable iron and the metal has its limitations." While this is an opinion held by many who are not fully informed regarding the value of malleable iron, nevertheless, it is absolutely incorrect. For the benefit of those who desire to inquire further into the strength of malleable iron we would suggest that they read Enrique Touceda's discussion entitled "Remarks on the Strength and Ductility of Malleable Cast Iron After the Skin Has Been Removed," in Vol. XXIII, of the *Transactions of the American Foundrymen's Association*, pages 440 to 450 inclusive. Prof. Touceda has made a life study of malleable iron and is considered one of the highest authorities on this subject. Mr. Keep states that it would do no harm in such light castings to increase the silicon to 1.10 per cent. However, there are five elements to be considered in making malleable iron mixtures and any statement concerning the percentage of any one without taking into consideration the other elements would be an almost absurdity, with the possible exception of phosphorus, which is not controlled in a malleable foundry and upon which a maximum limit is specified in the pig iron. The statement "If the sulphur is above 0.05 per cent, you may be obliged to sell some of your scrap iron rather than remelt it," likewise is without foundation. The best manufacturers of malleable iron today do not fear the sulphur content as it is found in the pig iron or in the scrap, as they have learned how to handle even an extreme percentage of this element without injury to the quality of the iron. The writer will be pleased to receive for inspection the five samples referred to by Mr. Keep, although from the very clear description published it is evident that the difficulties can be traced to unequal proportioning of sections, a practice which malleable foundrymen are endeavoring to eliminate by the education of consumers. Unfortunately, many erroneous ideas are prevalent concerning the characteristics and limitations of malleable iron and it would be well for consumers to refer their difficulties to an experienced malleable founder.

The property of the Gray Iron Co., Beaver Dam, Wis., has been sold to Sam C. Elser.

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A monthly journal devoted to all branches of the foundry trade

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Trade Outlook

ALL casting producing centers report a distinct improvement in trade conditions, and while the amount of new tonnage offered is not large, nevertheless it is of sufficient proportions to warrant a considerable increase in the melt and steadier operations. Machinery shops are filled with rush orders for tool builders and the automobile manufacturers continue to crowd the shops that specialize in motor car castings. The increased demand for foundry equipment reflects the general improvement in the foundry trade and greater interest is being manifested in the erection of new shops and in additions to existing plants. The big feature of the pig iron market were the heavy sales of foundry grades made by Buffalo furnaces, which aggregate more than 200,000 tons for the month. Some of this iron was sold as low as $11.50 for No. 2, although the price rebounded quickly to $12. In other centers foundry grades are quoted as follows: No. 2, Pittsburgh, $13.80; Chicago, local, $13; Philadelphia, $14.25 and Birmingham, $9.25 to $9.50. Malleable is unchanged at $12, Buffalo, and $13, Chicago, while Lake Superior charcoal is held at $15.75, Chicago.

Pig Iron Output in 1914

ACCORDING to statistics issued by the American Iron and Steel Institute, the production of all grades of pig iron in the United States in 1914 was 23,332,244 tons, as compared with 30,966,152 tons in 1913. The output was the smallest since the panic year of 1908 and reflects the depressed condition of the metal-working industry last year. Pennsylvania, as usual, was the largest producer with a total of 9,733,369 tons and Ohio was second with 5,283,426 tons. These two states respectively produced 41.72 and 22.64 per cent of the country's total. Charcoal iron production showed a heavy decline from 339,981 tons in 1913 to 263,924 tons in 1914. The figures compiled showing the total iron produced for consumption and for sale are interesting, inasmuch as more than two-thirds of the iron made was used directly by the steel works, whereas only 7,362,980 tons were produced for sale to foundries, steel works, etc. The decline in requirements of the foundry trade is indicated by the falling off in the production of foundry and malleable iron. The output of foundry iron in 1914 was 4,533,254 tons and malleable iron 671,771 tons. In 1913 the production of foundry iron was 5,220,343 tons and malleable iron, 993,736 tons.

Organized Foundry Labor

THAT the activities of the International Molders' Union not alone is confined to labor problems is indicated by its report covering the payment of strike, death, disability, sick and out-of-work benefits. Since the organization of this union and up to Dec. 31, 1914, $8,457,150.50 has been paid to the members and heirs from this fund. That the members of this society felt the stress of the depression last year is indicated by the issue of 143,337 out-of-work stamps, as compared with 57,215 the previous year. The large number of out-of-work stamps issued during 1914 represents a loss in revenue to the organization of $57,334.80. During the past year, sick, disability and death benefits to the amount of $248,331.60 were paid.

The E. H. Mumford Co.

The E. H. Mumford Co., Front and Franklin streets, Elizabeth, N. J., announces its return to the molding machine business. An arrangement has been made with the Samuel L. Moore & Sons Corporation, at Elizabethport, N. J., for the manufacture of Mumford molding machines and temporarily, during the construction of the first machines, the address of the E. H. Mumford Co. will be Elizabeth, N. J. Not only will a complete line of molding machines be put on the market and made interchangeable with all previous Mumford machines so far as practicable, but it is stated that the new machines will embody many points of merit made possible in redesigning. Mr. Mumford directs attention to the fact that after a period of 15 years he is again located at the same place where he joined Harris Tabor in the development of the first vibrator molding machines in 1895.

Cleveland Electroplaters

The Cleveland branch of the American Electro-Platers' Society is making excellent progress and the membership is rapidly being increased. Meetings are held the second and last Saturday of each month at room 217, Young Men's Christian Association building, to which all employers and platers are invited. Papers on various plating subjects are presented and discussed at each meeting.

Yale & Towne Mfg. Co. Changes

Henry R. Towne, for a period of 46 years president of the Yale & Towne Mfg. Co., New York City, with works at Stamford, Conn., has signified his desire to retire from the duties and responsibilities he has so long carried. Therefore, the office of chairman of the board of directors was created, to which Mr. Towne was elected. Walter C. Allen, vice president and general manager for a number of years, was elected president to succeed Mr. Towne. Mr. Allen entered the employ of the company 23 years ago. Schuyler Merritt, senior vice president of the company, will continue to hold that position and will devote special attention to the company's patent affairs and to the general direction of the bank lock department. He has been in the company's service for 37 years. J. H. Towne will continue as secretary. He entered the service of the company 24 years ago. John B. Milliken, treasurer, and Joseph A. Horne, general superintendent, will continue in those positions. It will be noted that the executive management remains substantially as in the past and is in the hands of men long identified with the company.

At a meeting of the stockholders held March 11 an increase in the capital stock of $500,000 was authorized. Substantially all of the present stockholders waived their rights of subscription to this additional stock in order thereby to enable its acquisition by the officers and employes on whom will rest the chief responsibility for the further development and continued success of the business.

As a measure of growth of the Yale & Towne Mfg. Co., it is pointed out that at the beginning of Mr. Towne's presidency the number of employes was less than 100, but in recent years this has been increased to over 5,000. Also, during the same period, the capital employed in the business has been increased from less than $100,000 to over $10,000,000. The executive and general offices of the company are located at No. 9 East Fortieth street, New York City, in a building erected and owned by the company. The Canadian business is conducted through a subsidiary corporation known as Canadian Yale & Towne, Ltd., located at St. Catherines, Ont.

Death of Zachary Taylor

Zachary Taylor, proprietor of the jobbing gray iron foundry operated by Taylor & Co., Brooklyn, N. Y., died Feb. 18 at Augustine, Fla. At an early age Mr. Taylor was apprenticed to the Jackson Foundry Co., New York City, and in 1876 he built a foundry in Menlo Park where he made castings for Thomas A. Edison. Several years later he returned to Brooklyn and assumed charge of the Johnston Bros. plant, which is now a part of the S. S. White Dental Mfg. Co. Later he was placed in charge of the Fulton Foundry Co., Brooklyn, and in 1892 he again engaged in business, operating a large foundry for making castings for the Edison Electric Co. and the Glen Cove Machine Works. In 1888 his plant was destroyed by fire and he accepted the general management of the foundry operated by the Edison Electric Co., Schenectady, N. Y. In 1892 he returned to Brooklyn, where he erected a large foundry and when the site was taken by the city and converted into a public park, he established the present plant on the square bounded by Nassau, Norman and Morgan avenues and Hausman street. Mr. Taylor is survived by a son, William E.

The Cleveland office of the Ayer & Lord Tie Co., Chicago, in charge of B. S. McConnell, has been removed to 926 Illuminating biulding.

Slow Cupola Melting

Referring to some of the articles recently published in *The Foundry* regarding slow melting difficulties experienced in some gray iron shops, I would like to call attention to my practice with a cupola lined to 36 inches. The tuyere area of this furnace is 9:1 and the distance from the sill to the bottom of the tuyeres is 13 inches, while from the bottom of the tuyeres to the top of the melting zone the distance is 20 inches. The bed charge of coke is 1,000 pounds with 1,500 pounds of iron and the intermediate charge consists of 1,500 pounds of iron and 150 pounds of coke, except the last two charges, when the coke is reduced to 100 pounds per charge.

Theoretically, the melting capacity of a 36-inch cupola is five tons per hour. This means that 15,000 cubic feet of air per hour must be blown through the tuyeres. Allowing for loss due to friction and leakage in the blast pipes and wind box, our positive pressure blower, with a displacement of 13.10 cubic feet per revolution and geared to 225 revolutions per minute, delivers 17,680 cubic feet of air per hour. We melt 22,000 pounds of iron in 2½ hours from the time the wind goes on until the bottom is dropped.

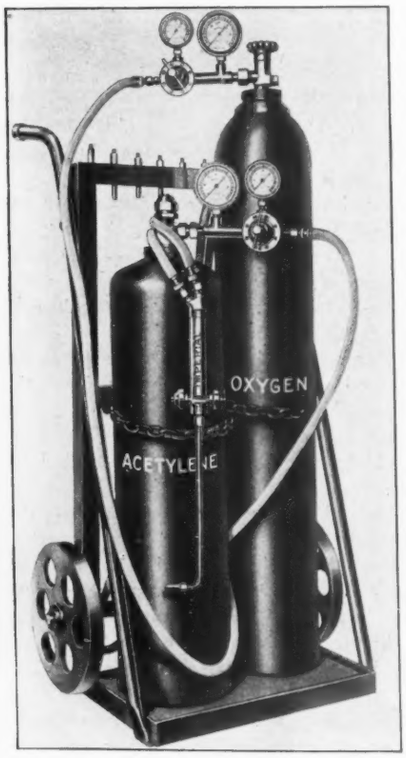
I do not think that it is practical to slag a cupola of this size. The blast chills the slag just above the tuyeres and this chilled slag, together with the coke around the tuyeres, will hang to some extent, regardless of how good the cupola practice is. Therefore, why increase the tendency to hang by producing more slag when it takes so little of this hanging to bridge a small cupola? In most heats we use from 75 to 80 per cent of scrap and we never have had any trouble with dirty iron that could be attributed to our failure to flux with either limestone or fluorspar.

The blast pressure averages from 14 to 16 ounces and when the blast is put on our pressure gage indicates from 6 to 6½ ounces. This shows that a good volume of air is passing through the tuyeres. About the middle of the heat the pressure starts to rise, due to the fact that the chilled slag and coke clogs the tuyere openings until a pressure of 9 ounces is attained. The pressure then remains between 8 and 9 ounces until bottom is dropped.

Regarding the slow melting problem, I believe that with a cupola of small size a greater tuyere area, higher volume with a correspondingly low pressure and without the use of limestone, better results can be obtained.

Imperial Oxy-Acetylene Equipment

Oxy-acetylene welding and cutting equipment embodying numerous new features now is being manufactured by the Imperial Brass Mfg. Co., 1202 West Harrison street, Chicago. To insure the safe, economical and continuous operation of oxy-acetylene outfits, it is essential that the thorough and uniform mixing of the gases be insured, and accurate regulation of both volume and velocity of the gases delivered to the mixing chamber of the torch are essential. Also, it is necessary to maintain a constant pressure under continuous operating conditons as well as to control a wide range of



PORTABLE OXY-ACETYLENE WELDING OUTFIT BUILT BY THE IMPERIAL BRASS MFG. CO., CHICAGO

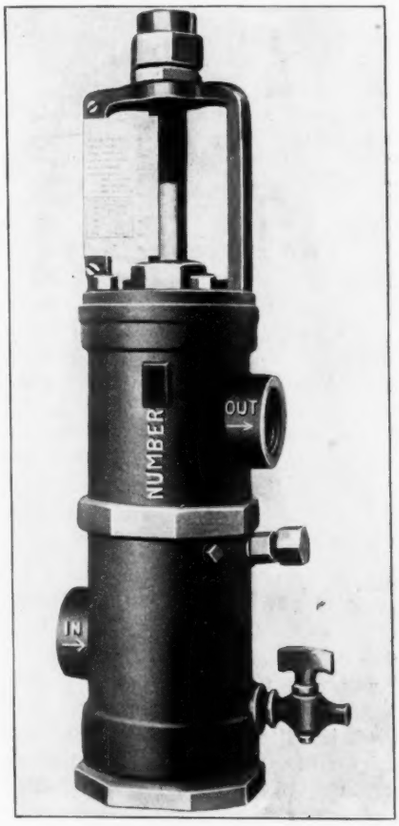
pressures for various requirements of service.

In the accompanying illustration is shown a portable oxy-acetylene welding outfit manufactured by the Imperial company. Before entering the mixing chamber the oxygen, at a high velocity, passes through a spiral groove which imparts to the oxygen a whirling motion, causing it to mix thoroughly with the acetylene, insuring thereby a uniform mixture before the gases reach the combustion point. It is claimed that a saving of oxygen is effected as well as an increased intensity of welding flame and high efficiency in cutting. The welding and cutting torches provided with this equipment are equipped with interchangeable tips to cover all ranges of work within the limits of the process. The needle valves permit fine adjustment and are located so that the operator can effect any desired regulation of the flame with the hand that holds the torch, making it unnecessary to lay aside the welding stick.

The welding tips are made of a special alloy having an extremely high melting point. The welding flame generated is a long, white, ncandescent jet, which is claimed to be free from carbons and oxides. The cutting tips are made from a special alloy and owing to their design they will cut a clean and an exceedingly narrow opening. The cutting flame is closely confined and is so proportioned that it insures a clean, quick, narrow cut with a minimum consumption of gas. The regulators deliver a constant, predetermined volume and velocity of gas to the torch and the movement of the valve with relation to the valve seat is limited in a way which prevents the cutting of the seat, thereby insuring long life. In cutting operations under high pressures the regulators shut off automatically in an emergency, a safety feature of great importance. The regulators are made in several types to cover every requirement of service from the lowest to the highest pressures and for corresponding variation in volume and delivery of gas required.

Automatic Air Meter for Foundries

An automatic air meter, which admits of ready application as a direct gage of the efficiency and consumption of compressed air of foundry tools, has been developed by the New Jersey Meter Co., Plainfield, N. J. A smaller meter also is made which is especially adaptable to compressed air machines and tools with a rated capacity not exceeding 60 feet per minute. The larger size, shown in the accompanying illustration, with a capacity of 50 to 300 cubic feet per minute, has been developed for service where the tools have a consumption of not over 300 feet per minute. The meter has only one moving element, consisting of a weighted piston in the upper or metering cylinder, a small piston in the oil dashpot cylinder and a rod joining the two pistons and extending upward into the sight glass at the top where it moves freely without contact. This rod rises and falls with the pistons, and its height in the sight glass corresponds exactly with the position of the piston in the metering cylinder. In this way, the top end of the rod registers the exact height of the latter, on the scale plate mounted outside of the sight glass. The air enters the chamber surrounding the dashpot cylinder and passes through parted openings into the interior of the metering cylinder. The wall of the latter is drilled with a number of small and accurately reamed holes, uniformly spaced. To pass to the outlet chamber, the air lifts the piston and exposes some of the holes to the flow. A small difference of pressure is thus established between the interior of the cylinder and the outlet chamber. The moving element rises until its weight is supported by the difference in pressure. The pistons and rod then are floating in static balance in a position corresponding exactly to the volume of air flowing, to the number of holes exposed and to the height of the top of the rod in the sight glass. The manner in which the moving element is made to float in air, rendering it frictionless and non-wearing, is claimed as one of the advantages of the meter.



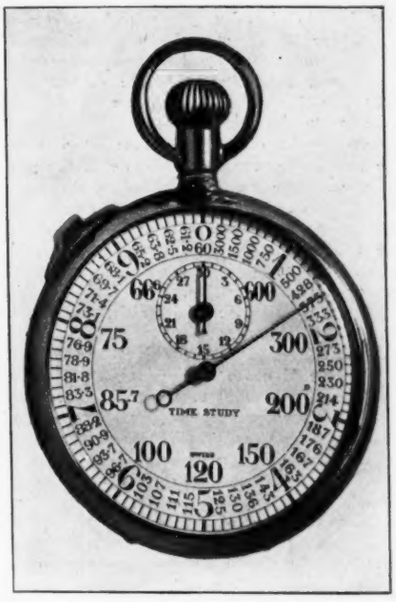
AUTOMATIC COMPRESSED AIR METER

A hanger for manufacturing plants on which are printed the safety rules for cranemen adopted by the safety committee of the National Founders' Association, has been issued by the Whiting Foundry Equipment Co., Harvey, Ill. The hanger is 14 x 27 inches, is printed in two colors and can be displayed to advantage in every manufacturing plant.

Time Study Watch

To meet requirements of time study in shop work a special stop watch has been devised with a decimal dial on which the minute is divided into tenths and hundredths. This has the effect of facilitating computations to a degree not possible with the ordinary watch. The dial also contains figures spaced 0.02 minute apart which indicate at any point of elapsed time the corresponding output per hour. This is a convenience when using the watch on punch presses, drop hammers, molding machines and similar devices.

As an illustration, let it be assumed one operation is shown by the watch to consume 0.76 minute, the hand shows by the figure under it that the output per hour at that rate is 78.9 operations. Had the hand stopped at 0.36 minute the output would be shown to be 167 per hour. In case of unusually short motions it is customary to time 10 operations and add a cipher to the reading showing output per hour. Thus if the time for 10 strokes of a press is shown to be 0.44 minute, the number per hour will be read as



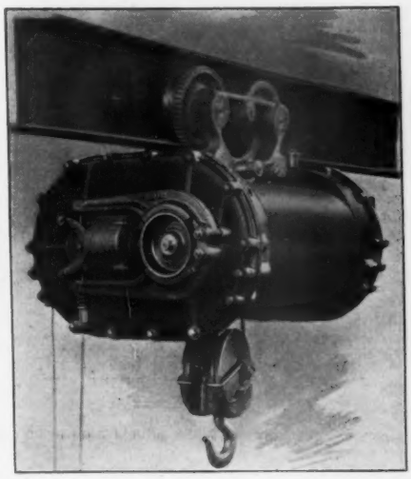
TIME STUDY WATCH

136 and adding a cipher will give 1,360 as the true number per hour. Exclusive sales rights for this time study watch have been placed in the hands of M. J. Silberberg and associates, Peoples Gas building, Chicago.

Frank D. Chase, architect, Peoples Gas building, Chicago, is preparing plans for a malleable iron foundry to be erected at Hammond, Ind. The foundry will be 70 x 340 feet, of brick and steel construction; the annealing house, 80 x 160 feet, and miscellaneous buildings will be 20 x 100 feet, also of brick and steel. The pattern vaults, bins, etc., will be built of concrete. A one-story brick office building also will be erected.

Electric Hoist

An improved type of electric hoist is being offered to the foundry trade by the Link Belt Co., Chicago. It is designed for exceptionally small head room, permitting its use in cases



LINK BELT ELECTRIC HOIST

where only a hand chain block can be employed under ordinary circumstances. A sheet metal cover on each side encloses all parts. The covers are easily removed, giving access to the motor on one side and the hoisting drum and controller on the opposite side. The heads of the end housings can be taken off exposing the spur gears, which may be slipped off without disturbing the shafts.

It is said that a successful effort has been made to reduce the number of parts, which lowers maintenance charges. A splash system lubricates the cut steel gears; this renders less attention necessary than when grease cups are used. A dynamic braking system is employed, the descending load driving the hoisting motor as a generator and using it for a brake. The hoist is said to be adapted for handling its load carefully and thus is available for shifting flasks and ladles in foundries. A solenoid brake holds the load automatically when the current is shut off and even if this brake should become inoperative, the load would not fall, but would descend slowly.

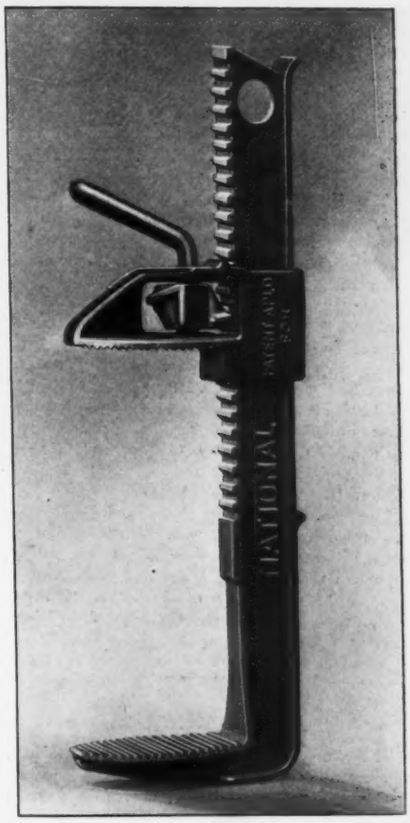
This hoist is built in five forms with either plain trolley, geared trolley, two forms of motor-driven trolley or with a shackle or hook suspension for stationary service.

Adjustable Foundry Clamp

An adjustable foundry clamp for use in place of clamping irons and wedges has been placed on the market recently by the National Clamp Co., 1657 Monadnock building, Chicago.

The clamp, as shown in the accompanying illustration, consists of a jaw with a tooth rack, on which a movable second jaw slides. The movable jaw carries a worm which is operated by a cold rolled steel handle. The worm has a single thread, part of which is cut out, permitting the sliding jaw to move freely up and down over the rack. The remainder of the thread engages in the teeth of the rack when the handle is turned. A ¾-inch clamping movement is obtained by one turn of the handle.

In operation, the stationary jaw is placed under and the movable jaw



ADJUSTABLE FOUNDRY CLAMP

on top of the flask, after which a short turn of the handle gives the pressure necessary to clamp tightly. The device is malleable iron, and is of simple construction. The claim is made that flasks are fastened quickly with a straight downward pressure, eliminating shifting and jarring. The action of the worm on the rack is positive and when drawn tight, the clamp will not loosen even on a jar-ramming machine. Five sizes are manufactured.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The capital stock of the Alloy Metals Foundry Co., Belleville Ill., has been increased from $2,500 to $5,000.

The Richardson & Boynton Co., Dover, N. J., stove and range manufacturer, will make extensive repairs to its foundry.

The Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., has increased its capital from $250,000 to $300,000.

The Vinita Brass Works, Vinita, Okla., has been incorporated with $50,000 capital by J. F. Watkins, J. M. Jones and L. N. Ditto.

The Magnus Co., Detroit, Mich., has been incorporated with a capital of $100,000 to take over the foundry business of the National Fulton Brass Mfg. Co.

The Moser Pattern & Foundry Co., Newark, O., has been incorporated with a capital of $10,000 by F. W. Moser, Henry Wulfhoop, Otto Moessmang, J. N. Pugh and Edgar P. Pugh.

The Conron Mfg. Co., Danville, Ill., has been incorporated with a capital of $25,000 to engage in the manufacture of castings. The incorporators are T. W. Conron, F. E. Lessure and M. F. Keegan.

The K. & M. Brass & Aluminum Castings Co., Cleveland, has been incorporated with $10,000 capital by D. E. Morgan, John C. Barkley, L. G. Lommasson, E. Denner and John P. Dempsey.

The Chatham Malleable & Steel Mfg. Co., Ltd., Chatham, Ont., has been incorporated to engage in the manufacture of saddlery hardware. The incorporators are W. H. Westman, Ross Huff and A. D. Westman.

The Rath Aluminum & Brass Foundry Co., New Philadelphia, O., has been incorporated with $40,000 capital by C. J. Rath, N. W. Senhauser, R. S. Barton, C. H. Marlow, Walter Graff and W. A. Wagner.

The Riser & Molding Co., Brooklyn, N. Y., has been incorporated with $5,000 capital to engage in the manufacture of steel castings, ornamental iron, steel, brass and bronze. The incorporators are Charles P. Albee, Howard Fitzpatricks and J. G. Godfrey, 395 Westminster road, Brooklyn.

New Construction

The Romeo Foundry Co., Romeo, Mich., will erect a new plant.

The Wilmington Casting Co., Wilmington, O., will erect a plant.

The Crescent Brass Mfg. Co., Reading, Pa., will build a foundry for casting aluminum.

The American Piston Ring Co., Newark, N. J., will erect a one-story, brick plant at a cost of $10,000.

The Kennedy Foundry Co., Baltimore, Md., will build a 100 x 300-foot foundry to cost approximately $150,000.

The Scovill Mfg. Co., brass manufacturer, Waterbury, Conn., will erect a plant, 80 x 100 feet.

The Pittsburgh Valve & Fittings Co. contemplates the erection of an addition to its plant at Barberton, O.

The G. B. Essex Brass Co., Detroit, manufacturer of lubricating devices, is erecting a plant to replace part of its factory destroyed by fire.

Doyle & Co., Meadow and McKean streets, Philadelphia, will rebuild their foundry, which was damaged by fire.

The Scott Bros. Electric Co., Detroit, will erect a $12,000, 4-story foundry building, 28 x 105 feet, of brick and steel.

The Eagle Iron & Brass Foundry, Passaic, N. J., is building an addition to its plant which will increase the molding floor space 13,000 square feet.

The Franklin Brass Co., 100 Young street, Long Island City, N. Y., is about to take bids for a one-story, 62 x 100-foot addition to its foundry. T. Tillion & Son, 381 Fulton street, Brooklyn, are the architects.

The Pavey Electric Co., Charleston, W. Va., with works at Dunbar, W. Va., will erect an iron and brass foundry and is in the market for complete equipment and also supplies. Frank H. Pavey is secretary and treasurer.

The National Supply Co., Toledo, O., manufacturer of plumbers' supplies, has awarded the contract for the erection of a 1-story addition to its plant at a cost of approximately $17,000.

The Southwark Fdry. & Machine Co., Fifth street and Washington avenue, Philadelphia, has awarded the contract for the erection of a steel storage warehouse, 31 x 70 feet, to cost approximately $5,000.

A contract has been awarded for the erection of an addition to the plant of the West Steel Casting Co. at East Seventieth street and Lake Shore & Michigan Southern railroad, Cleveland.

NEW TRADE PUBLICATIONS

CAST IRON VOLUME BLOWERS. — Cast iron volume blowers built by the Clarage Fan Co., Kalamazoo, Mich., described in the March, 1915, issue of *The Foundry*, page 126, are illustrated in an 8-page circular recently issued by this company.

PNEUMATIC TOOLS. — The Chicago Pneumatic Tool Co., Chicago, has issued two circulars devoted respectively to electric drills and riveting hammers. The electric drills are adapted for operation on direct or alternating current and different types are offered for various service. The riveting hammer described is designed for driving rivets up to 1½ inches in diameter.

AIR HOISTS.—A four-page circular issued by the Northern Engineering Works, Detroit, is devoted to air hoists which are built in various sizes from 3 inches to 24 inches inside diameter of cylinder. These hoists are adapted to a wide variety of uses in foundries and industrial plants generally. Horizontal and compound air hoists of the movable or fixed type also are shown, as well as telescopic air hoists which often are used in locations where head room is limited and where a vertical hoist is still desirable. The lower cylinder of this hoist is lifted into the upper one and the piston or hook then is lifted in the usual manner.

PORTABLE AIR COMPRESSORS.—In a 32-page bulletin issued by the Ingersoll-Rand Co., New York City, portable air compressors are illustrated and described. These compressors have been developed expressly for use in industrial plants employing air tools in connection with work of a temporary or semi-permanent character. Their application is wide, the portable outfit being mounted on wheels to facilitate its use at or in close proximity to the work to be done. These units are built in steam-driven and electric-driven types. A four-page circular also has been issued which is devoted to air tools for drilling flat holes in rock.

STEEL TIES. — Steel ties for industrial railways of all kinds and particularly those installed in foundry yards and in casting plants are illustrated and described in a 42-page catalog issued by the Cambria Steel Co., Johnstown, Pa. Steel ties are offered as a substitute for wood ties, inasmuch as they have a longer life and the rail fastenings merely consist of flange buttons which clamp the rail flange securely to the tie at the proper gage. The tie is a rolled steel section, light in weight, and has ample strength. Spikes, of course, are entirely eliminated and the life of the steel tie may be greatly increased by the application of coal tar, asphaltum or a similar coating. The Cambria Steel Co. also manufactures light rails, from 12 to 60 pounds per yard.

FURNACES, PORTABLE HEATERS, ETC.—The Monarch Engineering & Mfg. Co., Baltimore, is sending to the trade three catalogs describing, respectively, its line of oil, gas, coke and coal-fired furnaces, portable heaters and drill steel forges. The line of furnaces relates particularly to the requirements of mines, mills, smelters, refiners, mints and manufacturers of articles of gold and silver. Furnaces of various types are shown including the double-chamber, crucible tilting and refining, crucible tilting melting, a new type of tilting crucible furnace for melting gold and silver, precipitates, brass, bronze, copper, aluminum, iron, ferro alloys and nickel where it is not advisable or convenient to use oil or gas and which employs coke, coal or charcoal; a non-tilting crucible furnace built for oil, gas or coke; pit type melting furnaces, mint type crucible furnaces, reverberatory melting and cupelling furnaces, sweep reducing furnaces, muffles, cyanide ovens, ladle heaters, fuel oil burners, etc. Portable heaters of various types also are included, which can be used to advantage in foundries for drying cores, lighting cupolas, skin-drying molds, etc., and for various industrial applications where a portable heater can be of service. The drill steel forges are designed for the use of oil as fuel and are made in portable and stationary types. A water-jacketed forge also is shown.